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THE PENNSYLVANIA STATE COLLEGE
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FASCICULUS

OF THE

School of Mines and Metallurgy

ANNOUNCEMENTS FOR

1907—1908

STATE COLLEGE, PA.
JUNE, 1907

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CALENDAR FOR 1907-1908

June 12 to September 19--Vacation

1907—September 17, *Tuesday* . . . Examinations for Admission.
1907—September 19, *Thursday, 8 a. m.* First Semester begins.
1907—November 22, *Friday* . . . . Pennsylvania Day.
1907—November 28, *Thursday* . . . Thanksgiving Day; Holiday.

December 20, 11.10 a. m. to January 7, noon--Vacation

1908—January 31, *Friday, 11.10 a. m.* . . . First Semester ends.
1908—January 31, to February 4, ... Recess between Semesters.
1908—February 4, *Tuesday, 8 a. m.* . . . . Second Semester begins.
1908—June 14 to 17 . . . . Commencement Week.

The Pennsylvania State College

FASCICULUS

OF THE

SCHOOL OF MINES AND METALLURGY

ANNOUNCEMENTS FOR
1907—1908

STATE COLLEGE, PENNSYLVANIA

JUNE, 1907

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ELECTED MEMBERS.

Name	*Residence.*	*Term Expires.*
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DESCRIPTION OF THE COLLEGE

THE College was chartered in 1855 and opened for students in 1859, as the "Farmers' High School," and its object then was to give an exclusively agricultural education. Its organization, however, was upon a collegiate basis from the beginning, and in 1862 its name was changed to "The Agricultural College of Pennsylvania." Subsequently, the Legislature of the State, having appropriated to it the income from the proceeds of the national land grant, and the field of its work having thus been necessarily enlarged, its name was, in 1874, again changed, and its legal title has since been "The Pennsylvania State College."

Location.—The institution is situated in the Borough of State College, in Centre County, and almost in the exact geographical center of the State. Its position, on a plateau, more than a thousand feet above the sea level, in the midst of a broad, rolling valley, with Muncy Mountain on the north, Tussey Mountain on the south, and Nittany on the east, secures a varied and beautiful landscape and a healthful climate.

Campus and Farm.—The College grounds contain four hundred acres. About sixty acres in the immediate vicinity of the buildings constitute the campus and furnish recreation grounds and sites for the College buildings. The campus, tastefully laid out and adorned with trees, shrubbery, flower gardens, walks and drives, is one of unsurpassed beauty.

Buildings.—The main College building is a plain and substantial structure of magnesian limestone, 240 feet in length, 80 feet in breadth, and five stories in height. It contains museums, class-rooms, and dormitories. The building is heated throughout with steam, is lighted by electricity, and is furnished on every story with pure water from a mountain stream. The sewerage system is well devised and frequently inspected. The unusual exemption of students from sickness testifies to the excellent sanitary condition of all the College buildings.

Within the last few years, the College has greatly enlarged its facilities for instruction by the erection of new buildings, the reconstruction of old ones, and has added much to the equipment of the various departments.

The leading departments of the various Schools have been provided with commodious and attractive buildings, designed and built with special reference to their needs. The drill-hall of the Military Department is also used as a gymnasium and is fitted up with the Sargent system of movable apparatus, baths, dressing-rooms, and other modern appliances.

The building for the accommodation of the Departments of Civil, Electrical and Mechanical Engineering is three stories high, with a deep and well-lighted basement, and has a frontage of 266 feet, with an extreme depth of 208 feet. It has been carefully planned with reference to the needs of the several branches of instruction to which it is devoted, and is amply provided with lecture-rooms, laboratories, shops, testing-rooms, room for department libraries, model-room, etc., and equipped with the most modern machinery and appliances.

During the past four years the College has added a number of new buildings, costing more than $600,000.

These include an Auditorium, costing over $150,000, the gift of Mr. and Mrs. Charles M. Schwab, which was dedicated in June, 1903; a Library building, costing $150,000, given by Andrew Carnegie, Esq., which was dedicated in November, 1904; Agricultural buildings, to cost when completed, over $300,000, the funds for which are being provided by the State: of these the Dairy Building, which has been pronounced one of the finest in the world, is now in use.

McAllister Hall is a large, light-colored brick building, four stories in height, containing a dining-room capable of seating 900 persons at one time, and has dormitories for 140 students. A Track House has been provided for the members of the College athletic teams.

Through the generosity of friends of the School of Mines and Metallurgy a building has been erected and partially completed for the accommodation of the School, giving some 79,680 square feet of floor space.

The last Legislature has made an appropriation for the extension of this building, which it is hoped will be finished this year.

As planned the main portion is two stories high, 356 feet long and 40 feet wide, with a basement under 186 feet of its length. This building is joined by two wings, one two stories high, 172 feet long and 40 feet wide, and the other one, one story high and 270 feet long and 40 feet wide, with a basement 110 feet long. The second wing is joined by another short wing of 60 feet, one story, and basement. These buildings contain lecture rooms and laboratories, arranged and equipped for giving instruction in Crystallography, Mineralogy, Petrography, Geology, Mining Geology, Metallography, Metallurgy, Assaying, Ore Dressing, Coal Washing, Mining, and such other work as falls within the province of this School.

THE SCHOOLS AND THE COURSES OF THE COLLEGE

The several courses and branches of instruction are grouped in the following Schools:

1. **School of Language and Literature:**

BENJAMIN GILL, M. A., D. D., DEAN,

General Science Course,
Classical Course,
A Course in Modern Language and Literature,
Latin Scientific Course.

2. **School of History, Political Science, and Philosophy:**

ERWIN W. RUNKLE, M. A., Ph. D., ACTING DEAN.

The several subjects included in this School are incorporated more or less extensively into all the four years' courses. A separate course in Philosophy is offered, and other courses may be outlined hereafter. The work in these subjects, however, may be very largely elective.

3. **School of Agriculture:**

THOMAS FORSYTHE HUNT, M. S., D. Agr., DEAN.

Four years' courses in six distinct lines of work,
Five short courses of three months each,
Courses of instruction for farmers (one week),
Correspondence Courses (31 subjects),
Special work in Agriculture (one or two years).

4. School of Natural Science:

GEORGE GILBERT POND, M. A., Ph. D., DEAN.

Course in Biology,
Course in Chemistry,
Course in Industrial Chemistry.

5. School of Mathematics and Physics:

JOHN PRICE JACKSON, B. S., M. E., E. E., ACTING DEAN.

Course in Mathematics,
Course in Physics.

6. School of Engineering:

LOUIS E. REBER, M. S., DEAN.

Course in Civil Engineering,
Course in Electrical Engineering,
Course in Electrochemical Engineering,
Course in Mechanical Engineering,
Course in Sanitary Engineering,
Elementary Course in Mechanics (two years).

7. School of Mines and Metallurgy:

M. EDWARD WADSWORTH, M. A., Ph. D., DEAN.

Six four years' courses or options in Mines and Metallurgy,
Short Courses in Mines and Metallurgy (two years),

MINES AND METALLURGY

THE School of Mines and Metallurgy, if it properly attends to the instruction within its province, needs to cover the work of searching for the crude mineral materials of the earth, their mode of occurrence, the methods of taking them out of the ground, and their methods of preparation for market.

This requires that the School give instruction in the forms of minerals, their properties and characteristics, including Crystallography, the use of the goniometer and polariscope, or Optical, Microscopical, Descriptive, and Determinative Mineralogy.

It must give instruction in the study of the rocks, including the meteorites, their general and microscopical characters, as covered by the science of Lithology and Petrology or Petrography.

In the study of the earth it is necessary to cover the general principles of Chemical, Physical, Stratigraphical and Field Geology, particularly in their applications to Mining and Engineering. It must further include the study of the ancient animals and plants or Palaeontology, with its use in determining the age and relations of geological formations.

On the side of Economic or Mining Geology there are to be studied all the Metalliferous and Non-Metalliferous Deposits of use to man. This work takes up their mode of occurrence and classifications; the methods of searching or prospecting for them; their uses or applications. Naturally this division includes the geology of all ores; building and road materials; ornamental stones and gems; refractory materials; limes, mortars and cements; ceramic materials, like clays, etc.; fluxes; materials for glass making; abrasives; fuels, like coal, coke, lignite, peat, petroleum, and natural gas; graphite, mineral paints, mineral lubricants; fertilizers; salts; pyrotechnic materials; mineral medicines, and chemical materials.

The work further includes coal testing, valuation and washing, the testing and valuation of other mineral fuels, and the preparation and concentration of ores and other mineral substances for market (Ore Dressing and Coal Washing).

The work of the School includes Metallurgy in all its branches, comprising wet and fire assaying; the preparation and use of fuels and refractory materials; calorimetry; pyrometry; and furnaces, their construction, equipment, and use, with experimental laboratory work. Owing to its location, particular attention must be given to iron and steel metallurgy and to the manufacture of coke.

Lastly, Mining in all its numerous ramifications must be covered, including the various subjects of boring or drilling; supporting or timbering; operating or exploitation, including open cut mining or quarrying; hydraulic mining and dredging; mining law; legislation; care and education of the miner; accidents; emergencies; employment and management of labor; explosives and breaking ground; haulage or tramming, hoisting or winding; drainage or pumping; ventilation; lighting; mine air and gases; mine accounts; and the application of Mathematics and Mechanics to Mining or Mining Engineering; also the designing of mine plants, the laying out of mines, the planning of the ventilation; extinguishing of mine fires; methods of rescue, first aid in accidents, etc., etc.

The instruction, then, either in this School or in some of the other Schools in this College, must comprise all things requisite to find and obtain the earth's mineral wealth and prepare it for market. This requires that the School's students should be trained to prospect or to conduct exploitations in the forest and field; to distinguish the useful minerals and rocks; to understand the geological principles that govern the formation and association of useful mineral products, and to determine approximately their values; to study ores, building stones, limes, mortars, cements, coal, salt, gypsum, petroleum, natural gas, clays, fertilizers, gems, and other useful mineral products; to survey, map, and lay out grounds, railroads, tramways, and towns; to select or design hoisting, transportation, power, and light plants; to design mills, furnaces, docks, dams, bridges, shaft and rock houses, and other structures; to determine in each case which is the most suitable method for opening and conducting a quarry or mine, and of timbering, ventilating, and draining it; to assay, concentrate, and smelt ores; to investigate the strength and other properties of engineering materials, that designs may be intelligently worked out; to make working drawings to illustrate fully these designs; to understand the most economical methods of generating and using steam; to study in detail engines, pumps, boilers, and other machinery, and the methods of operating, testing, and preparing them; to master the principles of electricity and its generation, storage, transmission, and use as an illuminant and a source of motive powers; to study hydraulics, and its various applications in civil affairs and hydraulic mining; to understand mine management and accounts; explosives, mine gases, and the prevention of explosions and fires; to be helpful in accidents and emergencies; to understand the laws of production and supply, wages, moral and educational policies and other economic problems; historical development; needed languages; ability to write intelligently about, and report upon his work to, his employers and others; in short, to train men to be of real use in any line of work connected with the winning and reduction of mineral products; and to be good as well as useful citizens, looking to the interests of those under their charge, as well as to those of their employers, and those of the State and Nation. Seemingly there is no problem in life that mining men may not be confronted with.

Such work naturally arranges itself along various clearly defined lines, in each of which the training may proceed to almost any length; hence the branches of study which most naturally resolve themselves into specialties are drawing and designing, chemistry, metallurgy, ceramics, cement and glass making, mechanical, civil, electrical, and mining engineering, mining, ore dressing, coal washing, mineralogy, petrography, geology, mining geology, civics, and economics. In consequence, the men educated in mining courses are engaged quite commonly as Foremen, Fire-bosses, Mine Inspectors, Draughtsmen, Surveyors, Engineers, Woodsmen, Prospectors, Explorers, Assayers, Metallurgists, Mill-Men, Mining Men, Mineralogists, Petrographers, Geologists, Mining Geologists, Quarrymen, Manufacturers, Superintendents, Managers, Agents, Teachers, etc., etc.

Men trained along these lines may be employed in the humbler work about mines, mills, and smelting works, or they may have charge of the expenditure of many millions of dollars yearly and have the oversight of thousands of human beings, as well as burdened with the care of their religious, moral, social, educational, sanitary, and political welfare.

It needs but a glance at the immense fields covered by the work properly belonging to this School to see that by no possibility can it all be crowded into any single four years' course that the mind of man can conceive. Either the work must all be of a very elementary and introductory character or it must be somewhat specialized.

The amount of work is so great that no man can do more than to obtain part of the general principles and build upon them in some one of the numerous lines of mining, metallurgical, and geological practice.

Out of the numerous lines along which educational courses can be laid, some, like the following, can be specified as training men:

1. To engage in prospecting and exploring work, and to possess a thorough knowledge of the useful geological deposits, and their mode of occurrence—the application of Mineralogy, Petrography, and Geology to Mining—Prospectors and Mining or Economic Geologists, or Mining "Experts."

2. To cope with transportation problems, mapping, surveying, laying out of towns, railroads, erecting structures, etc.—The application of Civil Engineering to Mining and Metallurgy—Surveyors, Superintendents, and Mining Engineers.

3. To design metallurgical, hoisting, and power plants, including compressors, drilling machines, etc. To attend to ventilation and other allied problems.—The application of Mechanical Engineering to Mining and Metallurgy—Draughtsmen, Inspectors, Metallurgists, etc.

4. To look after the electrical power, lighting, signals, haulage, electric drills, cutters, etc., in a mine—the application of Electrical Engineering to Mining and Metallurgy—Mining and Metallurgical Engineers.

5. To do wet and fire assaying, smelting, coke preparation, electro-metallurgical work, etc.—the Metallurgi-

cal and Chemical side of Mining—Metallurgical Engineers, Metallurgists, and Assayers.

6. To understand the problems involved in Stamp Mills and other Concentrating plants.—The Ore Dressing and Coal Washing side of Mining—Mill-men, Superintendents, etc.

7. The management of mining or mineral properties or estates, including the mining laws. To have a gentleman's or a lawyer's education on one hand and a mining one on the other.—The application of the principles of Business and Law to Mining and Metallurgy—Managers and Agents.

8. To be prepared to handle the problems relating to building stones, including slates, clays, limes, mortars, cements, also gas, petroleum, water, etc.—The application of geological and mining principles to ceramics, the preparation of cements and other Building Materials—Foremen, Prospectors, Superintendents, Managers, etc.

9. To become general utility men about the smaller mines and mineral properties, who must be able to do in a limited way almost any kind of work above mentioned—Mining-men, Foremen, Superintendents, etc.

10. To serve as teachers or educators for students in mining, metallurgy, ceramics, geology, mineralogy, etc.—Instructors and Professors.

11. To train men for work in various lines upon the geological surveys of the country—Geologists and Explorers.

Men to do the above work well about mines and other mineral properties must receive a special training in, and knowledge of, the minerals and rocks as well as in the geological structure of the earth, and the general methods of mining. It thus becomes necessary, or at least advantageous, for the student to take the needed geological and mining studies, and to finish out his course with the special subjects he is expected to use.

To repeat, it can be said, that at this day it is impossible to train all men in a single course in mining, unless all are to be turned out as general utility or mediocre men, or all warped in a fixed direction, and suitable for one or two lines of mining only. It is not the men who know a little of every thing that lead, it is rather those who realize that they know some one thing well and have the mental strength that comes from such knowledge and its attendant discipline.

The range of subjects bearing on the mineral industry is extremely wide. This, coupled with the fact that all men are endowed with a natural aptitude for some lines of work, while wholly unfitted for others, and the further fact that circumstances beyond control force some men into particular occupations and deprive them of the opportunity to prosecute a full course of training, all conspire to demonstrate the correctness of the modern educational view, that a single rigid set course of instruction in higher educational institutions is now out of date, and that the student must have some liberty in selecting the studies which are to enable him to cope with his life-work. This is recognized here, and met by selecting certain studies that are considered essential for any man to have who is to devote himself to studying subjects germaine to the purposes of this School, with additional subjects from which the student is to select enough to complete his course.

Out of the numerous schemes for courses that could be adopted to reach the end sought—to give the best, highest, and most practical education, in accordance with the demands of the times—the courses given below with their various options and electives are, perhaps, the nearest in line with those followed in the other Schools of this

College, that will satisfy the varied demands of the mining, metallurgical and geological industries. It is further intended that the education shall be the highest and best that it is possible to provide here.

The general scheme of the courses is to arrange for all some general studies for their educational, disciplinary and practical value, as well as some that are germaine to the work of every student in the School.

Besides these studies six options, or courses, are provided for with selectives and electives common to all, enabling students to obtain the advantages in their work that could otherwise only be had through formulating scores or hundreds of rigid courses in Mining, Geology, and Metallurgy. The degree of B. S. in Mining Engineering, or in Mining, or in Engineering Geology, or in Mining (Economic) Geology, or in Metallurgical Engineering, or in Metallurgy and Assaying, is given to the students completing the respective options so designated.

It is to be noted that any subject given in one option is elective for students taking other options if they are properly prepared. Every student is required to select his option and to follow it throughout his course, unless he changes his option under the rule providing for this.

In selecting his electives the student needs to note that the time is so brief that he can take only comparatively few subjects at any time—and that, owing to the sequence of subjects, he must follow some special line. Electives essential for the advanced work need not necessarily be taken in any specified year.

No elective subject will be given unless taken by a sufficient number of students, a number which will vary according to the conditions, but which may be stated to be in general at least five.

In arranging the work of the School a *period* or *semester period* is considered to be one hour of class room work or two hours of practicum or laboratory or field work.

For graduation a student is required to complete the number of periods specified in the courses. For the first year they are forty-nine or fifty, for the next two years they are forty-nine periods each, including three periods or one hundred hours of Summer School. For the fourth or senior year forty-six periods are required.

In order to enable the student to become better fitted for his future practice he is allowed to substitute each year for his elective semester work, sixteen periods or ten weeks' work of a specified kind during his summer vacation, if he desires to do so. In order to substitute the student first must arrange with the Dean of this School and the instructor who has charge of the subject, the details of the work, the company, and location. When the work has been completed, the student is further to present from the company for which he has worked a certificate stating the kind, character, and grade of work done and the time spent. The student must also present a written thesis giving in detail an account of the work he has done and then pass a written or oral examination upon the work and the principles involved.

SCHEDULE OF THE COURSES IN MINES AND METALLURGY.

The Abbreviation and numeral preceding a subject as "Mat. 1." is the reference number of the subject; as "Mat. 1," when used, stands for Mathematics I or Plane and Spherical Trigonometry. Numbers in ( ) as (5), after a subject, indicate the number of hours a week that subject is taken. Fractions (as 6-4) indicate the number of hours in the first and second halves of a semester, respectively.

Reference numbers standing after the numbers in ( ) indicate subjects that must be completed before the main subject is taken. [ ] about a reference number indicate a subject that must be taken either with or before the main subject, i. e. "Min. 2 Mineralogy and Petrography (1) Min. 1, Min.L. 6, [Min.L. 7]" indicates that one hour of "Mineralogy 1" must be preceded by the subjects of "Mineralogy 1" and "Mineralogical Laboratory 6," and that it must be accompanied with or preceded by the subject of "Mineralogical Laboratory 7."

When any class room subject is elected, its corresponding required practicum must be taken.

In many of the electives and in much of the required work there is no real reason why they should be taken in one year more than in another, except when necessary to preserve their sequence. Many Sophomore and Junior studies in this School are Senior or Graduate studies in other institutions and even in other Schools here—the position being largely due to the particular conditions in each case. A student must elect his studies in sequence, but is not necessarily confined to taking them in any particular year, if he can obtain the consent of the instructors and of the Dean or Deans concerned. In the same way a study belonging to a subsequent year, or even a graduate study, can be taken by any properly prepared student in an earlier year.

In special cases, particularly in the higher and in the laboratory work, more hours can be taken than those specified in the catalogue, by means of a petition and the consent of the instructor and Dean or Deans.

Changes in hours or subjects will be made from time to time to meet the changes in the courses in other schools or the needs in this one.

All students in these courses are required to take Military Drill during the Freshman and Sophomore years; and Forensics III and IV.

FOUR YEARS' COURSES IN MINES AND METALLURGY.

FRESHMAN YEAR.

FIRST SEMESTER.

Class Room Work, (Required 13 Periods).

En. 1.	Rhetoric (5).
Mat. 1.	Plane and Spherical Trigonometry (5).
Min. 1.	Crystallography and Mineralogy (2).
Mil. 1.	Military Tactics (1).

Practicums or Laboratory Work, (Required 6 Periods or 12 Hours).

Dr. 2.	Mechanical Drawing and Designing (5).
Min. L. 5.	Crystallography and Mineralogy (7).

Selectives,

Class Room Work. (Required 4 Periods).

Fr. 1.	French (4).
Ger. 1.	German (4).
Sp. 1.	Spanish (4).
Lat. 1.	Latin (4) or
Gr. 1.	Greek (4).

SECOND SEMESTER.

Class Room Work, (Required 12-11 Periods).

En. 2.	Argumentation (2), En. 1.
Ch. 1.	General Chemistry and Qualitative Analysis (5-4), [Ch. 2].

Practicums, (Required ⅞ Periods or 14-16 Hours).

Ch. 2.	Elementary Chemistry and Qualitative Analysis (4-6), [Ch. 1].
Min. L. 6.	Mineralogy and Petrography (10-6), Min. 1, Min.L. 5, [Ch. 1, 2].
Sur. 1.	Surveying (0-4), Mat. 1.

Selectives:

Class Room Work, (Required 4 Periods).

Fr. 2.	French (4), Fr. 1*;
Ger. 2.	German (4), Ger. 1;
Sp. 2.	Spanish (4), Sp. 1;
Lat. 3.	Latin (4), Lat. 1 or
Gr. 3.	Greek (4), Gr. 1.

Practicums, (Required ¼ Period or 0-1 Hour).

Fr. 2a.	French Sight Reading (0-1), [Fr. 2];
Ger. 2a.	German Sight Reading (0-1), [Ger. 2];
Sp. 2a.	Spanish Sight Reading (0-1), [Sp. 2];
Lat. 3a.	Latin Sight Reading (0-1), [Lat. 2]; or
Gr. 3a.	Greek Sight Reading (0-1), [Gr. 2].

OPTIONS.

I. MINING ENGINEERING; III. ENGINEERING GEOLOGY; V. METALLURGICAL ENGINEERING.

Class Room Work, (Required 5 Periods).

Mat. 2.	Analytic Geometry (5), Mat. 1.

II. MINING; IV. MINING (Economic) GEOLOGY; VI. METALLURGY AND ASSAYING.

Class Room Work, (Required 1 Period).

Min. 2.	Mineralogy and Petrography (1), Min. 1, [Ch. 1, 2; Min.L. 7].

Practicum, (Required 5 Periods).

Min. L. 7.	Mineralogy and Petrography (10), [Ch. 1, 2; Min. 2].

SUMMER SCHOOL.

Practicum, (Required 100 hours or 3 Periods).

Sur. 2.	Surveying (100 hours), Sur. 1.

*The corresponding practicum must be selected with any languages.

ELECTIVE WORK. SUMMER VACATION.

Practicums, (16 Periods).

M. Lab. 21.	Practical Work in Surveying (10 weeks). Sur. 2.
M. Lab. 22.	Practical Work in Mining (10 weeks).

SOPHOMORE YEAR.

FIRST SEMESTER.

Class Room Work, (Required 3 Periods).

Geol. 6.	General and Field Geology (3), Min. L. 7 or [Min.L. 7].

Selectives:

Class Room Work, (Required 3 Periods).

Fr. 3.	French (3), Fr. 2.
Ger. 3.	German (3), Ger. 2.
Sp. 3.	Spanish (3), Sp. 2.
Lat. 4.	Latin (3), Lat. 2.
Gr. 4.	Greek (3), Gr. 2.

Practicums, (Required ½ Period or 1 Hour).

Fr. 3a.	French (1), [Fr. 3].
Ger. 3a.	German (1), [Ger. 3].
Sp. 3a.	Spanish (1), [Sp. 3].
Lat. 4a.	Latin (1), [Lat. 3].
Gr. 4a.	Greek (1), [Gr. 3].

OPTIONS.

I. MINING ENGINEERING.

Class Room Work, (Required 9 Periods).

Mat. 3.	Advanced Algebra (3).
Mat. 4.	Differential Calculus (2), Mat. 2.
Min. 2.	Mineralogy and Petrography (1), Min. 1, Ch. 1, 2; [Min.L. 7].
Mchs. 1.	Elementary Mechanics (3), Mat. 1.

Practicum, (Required 5 Periods).

Min. L. 7.	Mineralogy and Petrography (10), [Min. 2].

Electives, (Required 2½ Periods).

II. MINING.

Class Room Work, (Required 3 Periods).

Mchs. 1.	Elementary Mechanics (3), Mat. 1.

Practicums, (Required 4½ Periods).

Sh. Pr. 2.	Carpentry (5).

Sh. Pr. 14.	Forging (4).

Electives, (Required 3 Periods).

III. ENGINEERING GEOLOGY.

Class Room Work, (Required 9 Periods).

Mat. 3.	Advanced Algebra (3).
Mat. 4.	Differential Calculus (2), Mat. 2.
Min. 2.	Mineralogy and Petrography (1), Min. 1; Ch. 1, 2; [Min.L. 7].
Mchs. 1.	Elementary Mechanics (3), Mat. 1.

Practicum, (Required 5 Periods).

Min. L. 7.	Mineralogy and Petrography (10), [Min. 2].

Electives, (Required 2½ Periods).

IV. MINING (ECONOMIC) GEOLOGY.

Class Room Work, (Required 3 Periods).

Geol. 7.	Paleozoic Geology (2), Min.L. 7, [Geol. 6, G. Lab. 1, Pal. 1, Pal.L. 1].
Pal. 1.	Paleontology (1), [Pal. L. 1, Geol. 7].

Practicums, (Required 5 Periods).

Pal L. 1.	Paleontology (4), [Geol. 7, Pal. 1].
G. Lab. 1.	Field Geology and Geological Surveying and Mapping (6), [Geol. 6].

Electives, (Required 3½ Periods).

V. METALLURGICAL ENGINEERING.

Class Room Work, (Required 9 Periods).

Mat. 3.	Advanced Algebra (3).
Mat. 4.	Differential Calculus (2), Mat. 2.
Min. 2.	Mineralogy and Petrography (1), Min. 1, Ch. 1, 2; [Min.L. 7].
Mchs. 1.	Elementary Mechanics (3), Mat. 1.

Practicums, (Required 7¼ Periods).

Min. L. 7.	Mineralogy and Petrography (10), Ch. 1, 2; [Min. 2].
Ch. 3.	Qualitative Chemical Analysis (4½), Ch. 1, 2.

VI. METALLURGY AND ASSAYING.

Practicums, (Required 6¾ Periods).

Ch. 3.	Qualitative Chemical Analysis (4½), Ch. 1, 2.
Sh. Pr. 2.	Carpentry (5).
Sh. Pr. 14.	Forging (4).

Electives, (Required 9¾ Periods).

ELECTIVE WORK.

Class Room Work.

En. 7.	American Literature (4), En. 4.
Fr. 8.	French (2), [Fr. 3.].
Dr. 14.	Descriptive Geometry (1), Dr. 2, Mat. 2, [Dr. 15].
Phy. 1.	Mechanics and Heat (4), Mat. 1.
Ch. 15.	Lectures on the Carbon Compounds (2), Ch. 1.
Zo. 2.	General Biology (2).
Sur. 6.	Surveying (1), Sur. 2. [Sur. 7].
Geol. 3.	Elements of Physical Geography (2), Min. L. 6, [Min. L. 7, Geol. 6].
His. 1.	General History (3).

Practicums.

Dr. 15.	Descriptive Geometry (4), Dr. 2, Mat. 2, [Dr. 14].
Ch. 4.	Qualitative Chemical Analysis (7), Ch. 1, 2.
Zo. 1.	Elementary Zoology (4).
Zo. 3.	Biology (3), [Zo. 2].
Sur. 7.	Topographical Drawing and Surveying (4), Sur. 2, [Sur. 6].
Pal. L. 11.	Paleontology (2 to 12), [Pal.L. 1].
G. Lab. 3.	Field Geology, Geological Surveying and Mapping (2 to 12), [G. Lab. 1].
Sh. Pr. 1-7.	Carpentry (2-3).
Sh. Pr. 8, 9.	Wood Turning (7-0 or 8-0).
Sh. Pr. 11-14.	Forging (2 to 6).
Min. L. 8.	Mineralogy and Petrography (2 to 12), Min.L. 7 or [Min.L. 7].

SECOND SEMESTER.

Class Room Work, (Required 6 Periods).

Mine 1.	The Principles of Mining (3), Geol. 6, Min.L. 7.
M. Geol. 1.	Mining (Economic) Geology (3), Geol. 6, Min. L. 7.

OPTIONS.

I. MINING ENGINEERING.

Class Room Work, (Required 7½ Periods).

Dr. 17.	Descriptive Geometry (2-0), Dr. 2, Mat. 2, [Dr. 16].
Mat. 5.	Differential and Integral Calculus (5), Mat. 3, 4.
Sur. 9.	Mining Surveying (2-1), Sur. 2, [Sur. 10].

Practicums, (Required 3½ Periods).

Dr. 16.	Descriptive Geometry (2-6), [Dr. 17].
Sur. 10.	Mining Surveying (2-4), Sur. 2, [Sur. 9].

Electives, (Required 6 Periods).

II. MINING.

Class Room Work, (Required 1½ Periods).

Sur. 9.	Mining Surveying (2-1).

Practicums, (Required 7½ Periods).

Sh. Pr. 28.	Chipping, Filing, and Pipe Fitting (2).
Sh. Pr. 29.	Machine Tool Work (4), Sh. Pr. 14.
G. Lab. 2.	Field Geology, Geological Surveying and Mapping (6), Geol. 6.
Sur. 10.	Mining Surveying (2-4), Sur. 2, [Sur. 9].

Electives, (Required 8 Periods).

III. ENGINEERING GEOLOGY.

Class Room Work, (Required 7½ Periods).

Dr. 17.	Descriptive Geometry (2-0) Dr. 2, Mat. 2, [Dr. 16].
Mat. 5.	Differential and Integral Calculus (5), Mat. 3, 4.
Sur. 9.	Mining Surveying (2-1), Sur. 2, [Sur. 9].

Practicums, (Required 3½ Periods).

Dr. 16.	Descriptive Geometry (2-6), [Dr. 17].
Sur. 10.	Mining Surveying (2-4), Sur. 2, [Sur. 9].

Electives, (Required 6 Periods).

IV. MINING GEOLOGY.

Class Room Work, (Required 3 Periods).

Geol. 8.	Mesozoic and Cenozoic Geology (2), Geol. 7, [Pal. 2, Pal. L. 2, G. Lab. 2].
Pal. 2.	Paleontology (1), Pal. 1, Geol. 7, [Geol. 8, Pal. L. 2].

Practicums, (Required 5 Periods).

Pal. L. 2.	Paleontology (4), Pal. 1, Pal. L. 1, [Geol. 8, Pal. 2].
G. Lab. 2.	Field Geology and Geological Surveying and Mapping (6), Geol. 6.

Electives, (Required 9 Periods).

V. METALLURGICAL ENGINEERING.

Class Room Work, (Required 6 Periods).

Mat. 5.	Differential and Integral Calculus (5), Mat. 3, 4.
Ch. 5.	Quantitative Chemical Analysis (1), Ch. 3.

Practicums, (Required 5 Periods).

Ch. 6.	Quantitative Chemical Analysis (10), Ch. 3.

Electives, (Required 6 Periods).

VI. METALLURGY AND ASSAYING.

Class Room Work, (Required 1 Period).

Ch. 5.	Quantitative Chemical Analysis (1), Ch. 3.

Practicums, (Required 9½ Periods).

Sh. Pr. 8.	Wood Turning (7-0).
Sh. Pr. 18.	Pattern Making (0-7). Carp. 72 hours, Wood Turning 55 hours.
Sh. Pr. 24.	Foundry (2), Sh. Pr. 18.
Ch. 6.	Quantitative Chemical Analysis (10) Ch. 3, [Ch. 5].

Electives, (Required 6½ Periods).

ELECTIVE WORK.

Class Room Work:

Fr. 4.	French (3) Fr. 3.
Fr. 9.	French (1) Fr. 3.
Ger. 4.	German (3) Ger. 3.
Ger. 7.	German (2) Ger. 3.
Sp. 4.	Spanish (2) Sp. 3.
Lat. 6.	Latin, Horace and Juvenal (2), Lat. 4.
Gr. 6.	Greek, Thucydides and Plato (2), Gr. 4,
Phy. 2.	Electricity, Sound and Light (4), Mat. 1.
Phy. 3.	Electricity (4) [Mat. 5].
Ch. 5.	Quantitative Chemical Analysis (1), Ch. 3 or 4, [Ch. 6].
Bot. 1.	Botany (2).

Zo. 4.	General Biology (2) Zo. 2.
M. Des. 2.	Mechanics of Machinery (2), Dr. 2, Mchs. 1.
Geol. 4.	Advanced Physical Geography (2), Geol. 3 or 6, Min. L. 7.
Ph. 1.	Introductory Logic (3).
His. 2.	General History (3) His. 1.

Practicums:

En. 9.	Bibliography (2).
Dr. 19.	Stereotomy (4).
Phy. 5.	Physical Laboratory (4), [Math. 5].
Ch. 6.	Quantitative Chemical Analysis (8-0 to 12), [Ch. 5].
Bot. 2.	Botany (6) [Bot. 1].
Zo. 5.	Biology (2) Zo. 3 [Zo. 4].
Sur. 8.	Topographical Drawing and Advanced Surveying (2) Sur. 7.
Sh. Pr. 1 to 7.	Carpentry (2 to 8).
Sh. Pr. 8 to 9.	Wood Turning (4-0 to 8-0).
Sh. Pr. 11 to 14.	Forging (2 to 6).
Sh. Pr. 15.	Metal Work (2).
Sh.Pr.16,18,19.	Pattern Making (2 to 0-7) Carp. 72 hours, Wood Turning 55 hours.
Sh.Pr.22,24,25.	Foundry (0-2 to 0-4).
Sh. Pr. 29 to 36.	Machine Tool Work (2 to 12) Forging 64 hours.
Min. L. 9.	Mineralogy and Petrography (2 to 12) Min. L. 7.
Pal. L. 12.	Paleontology (2 to 12) [Pal. L. 2].
G. Lab. 4.	Field Geology and Geological Surveying and Mapping (2 to 12) [G. Lab. 2].
M. G. L. 1.	Mining Geological Laboratory (2 to 12) [M. Geol. 1].
M. Lab. 1.	Mining Laboratory and Design (4 to 12), Dr. 2, Mat 1, [Mine 1].

SUMMER SCHOOL.

Electives, (100 Hours or 3 Periods).

Practicums:

Sur. 11.	Geodetic and Topographic Surveying (100 hours), Sur. 8 or 10.
M. Lab. 18.	Mining Surveying (100 hours) Sur. 8 or 9.

Ch. 20.	Quantitative Chemical Analysis (100 hours), Ch. 5, 6.
G. Lab. 9.	Geological Field Work (100 hours), Geol. 6, G. Lab. 1 or 2.
M. G. L. 23.	Field Work in Mining Geology (100 hours), Min. L. 7, M. Geol. 1, Geol. 6, G.Lab. 1, 2.

ELECTIVE WORK. SUMMER VACATION.

Practicums, (16 Periods).

Min. L. 22.	Practical Work in Mineralogy (10 weeks), Min. L. 7.
G. Lab. 12.	Practical Work in Geology (10 weeks) Geol. 6, G. Lab. 1 or 2.
Pal. L. 21.	Practical Work in Paleontology (10 weeks), Pal. L. 1, 2.
M. G. L. 26.	Practical Work in Mining Geology (10 weeks), Min. L. 7, Geol. 6; G. Lab. 1, 2; M. Geol. 1.
M. Lab. 23.	Practical Work in Mining (10 weeks), Mine 1.

JUNIOR YEAR.

FIRST SEMESTER.

Class Room Work, (Required 3 Periods).

Met. 4.	The Principles of Metallurgy (3) Ch. 1, 2.

Practicum, (3 Periods).

Met. L. 17.	Assaying, Fire (6), Ch. 1, 2, Min L. 7.

OPTIONS.

I. MINING ENGINEERING.

Class Room Work, (Required 12 Periods).

Mchs. 2.	Applied Mechanics (5), Mat. 5, Mchs. 1, Dr. 2.
Hyd. 1.	Hydraulics (2), Mat. 5, Mchs. 1.
Mine 2.	Mine Gases, Ventilation, Lighting, Mine Accounts, "Laying Out" of Mines and Underground and Surface Plants (3), Mine 1, Mat. 1.
Mine 4.	Coal Mining (2), Mine 1.

Electives, (Required 5 Periods).

II. MINING.

Class Room Work, (Required 9 Periods).

Mine 2.	Mine Gases, Ventilation, Lighting, Mine Accounts, Laying out of Mines and Underground and Surface Plants (3), Mine 1, Mat. 1.
Mine 4.	Coal Mining (2), Mine 1.
M. Geol. 2.	Memetallites or Nonmetalliferous Deposits (2), Geol. 6, M. Geol. 1.
M. Geol. 9.	Building and Ornamental Stones (2), M. Geol. 1.

Electives, (Required 8 Periods).

III. ENGINEERING GEOLOGY.

Class Room Work, (Required 10 Periods).

Mchs. 2.	Applied Mechanics (5), Mat. 5, Mchs. 1, Dr. 2.
Pet. 1.	Optical Mineralogy and Microscopical Mineralogy and Petrography (3), Geol. 6, M. Geol. 1, Mine 1, Min. L. 7, [Pet. L. 1].
Hyd. 1.	Hydraulics (2), Mat 5, Mchs. 1.

Practicums, (Required 2 Periods).

Pet. L. 1.	Petrographical Laboratory (4), Min. L. 7, Geol. 6, Mine 1, M. Geol. 1, [Pet. 1].

Electives, (Required 5 Periods).

IV. MINING GEOLOGY.

Class Room Work, (Required 7 Periods).

Pet. 1.	Optical Mineralogy and Microscopical Mineralogy and Petrography (3), Geol. 6, M. Geol. 1, Mine 1, Min. L. 7, [Pet. L. 1].
M. Geol. 2.	Memetallites or Nonmetalliferous Deposits (2), Geol. 6, M. Geol. 1.
M. Geol. 9.	Building and Ornamental Stones (2), M. Geol. 1, Geol. 6, [Pet. 1, Pet. L. 1].

Practicum, (2 Periods)

Pet. L. 1.	Petrographical Laboratory (4), Min. L. 7, Geol. 6, M. Geol. 1, Mine 1, [Pet. 1].

Electives, (Required 8 Periods).

III. METALLURGICAL ENGINEERING.

Class Room Work, (Required 5 Periods).

Mchs. 2.	Applied Mechanics (5), Mat. 5, Mchs. 1, Dr. 2.

Practicums, (Required 6 Periods).

Met. L. 20.	Assaying of Ores, Slags, Fluxes and Metallurgical Products (6), Ch. 1, 2, 3, 5, 6; Min. L. 7, [Met. 4].
Met. L. 1.	General Metallurgical Experimentation (4), Ch. 1, 2, 3, 5, 6; Min. L. 8, [Met. 4].
Ch. 9.	Gas Analysis (0-4), Ch. 3.

Electives, (Required 6 Periods).

VI. METALLURGY AND ASSAYING.

Practicums, (Required 6 Periods).

Met. L. 20.	Assaying of Ores, Slags, Fluxes, and Metallurgical Products (6), Ch. 1, 2, 3, 5, 6; Min. L. 7; [Met. 4].
Met. L. 1.	General Metallurgical Experimentation (4), Ch. 1, 2, 3, 5, 6; Min. L. 7, [Met. 4].
Ch. 9.	Gas Analysis (0-4), Ch. 3.

Electives, (Required 11 Periods).

ELECTIVE WORK.

Class Room Work:

En. 10.	History of the English Language (3).
Fr. 5.	French (3), Fr. 4.
Fr. 10.	French (1), Fr. 3.
Ger. 5.	German (3), Ger. 4.
Ger. 8.	German (2), Ger. 3.
Sp. 5.	Spanish (3), Sp. 4.
Lat. 7.	Latin—Cicero and Seneca (2), Lat. 6.
Gr. 7.	Greek—Aeschylus and Theocritus (2), Gr. 6.
Mat. 6.	Differential Equations (2), Mat. 5.
Mat. 7.	Differential Equations (4), Mat. 5.
Phy. 19.	Theory of Light (3), Math. 5.
Ch. 6.	Quantitative Chemical Analysis (1), Ch. 5, [Ch. 8].
Bot. 3.	Botany (3), Bot. 1.
For. 1.	Timber Physics (1).
Zo. 6.	Zoology (4).
Pal. 3.	Paleontology (2), Pal. 2, Pal. L. 2, Geol. 8, [Pal. L. 3].
Ht. Eng. 1.	Steam Engines (2).
Ht. Eng. 3.	Boilers (1).
E. E. 1, 9.	Electro-Magnetism and the Construction of Dynamos (2 or 3), Mat. 5, Phy. 3.
Min. 3.	Mathematical Crystallography (2), Mat. 1, 2,

	Min. 1, 2; Min. L. 7; [Min. L. 14, Pet. 1, Pet. L. 1.]
Geol. 5.	Advanced Physical Geography, continued (2), Geol. 4, 6; G. Lab. 1, Min. L. 7.
Geol. 9.	Glacial Geology (2), Geol. 8.
M. Geol. 13.	Coal—Its Origin, Occurrence, Distribution, Properties, and Uses (2), M. Geol. 1, [M. Geol. 2, Pet. 1, Pet. L. 1].
Ph. 2.	Descriptive Psychology (4).
Mine 15.	Mine Hoisting and Haulage (2), Mine 1, [Mine 2, 4].

Practicums:

Phy. 6.	Physical Laboratory (4), Mat. 1.
Ch. 8.	Quantitative Chemical Analysis (8-0 to 12), Ch. 6, [Ch. 7].
Ch. 9.	Gas Analysis (0-2 or 0-4) Ch. 3.
Bot. 4.	Botany (4), Bot. 2, [Bot. 3].
For. 2.	Timber Physics (4), For. 1.
Zo. 7.	Zoology (6), [Zo. 6].
Sh.Pr. 29 to 36.	Machine Tool Work (2 to 14) Forging 64 hours.
El. Lab. 1.	Electrical Measurements (4) Phy. 3.
Min. L. 10.	Mineralogy and Petrography (2 to 12), Min. L. 7.
Min. L. 14.	Crystallographic Laboratory (4 to 12), Min. 1, 2, Min. L. 7; [Min. 3, Pet. 1, Pet. L. 1].
Pet. L 5.	Petrographical Laboratory (2 to 12), [Pet. L. 1].
Pal. L. 3.	Paleontology (4), Geol. 8; Pal. 2, Pal. L. 2.
Pal L. 13.	Paleontology (2 to 12), [Pal. L. 3].
G. Lab. 5.	Field Geology and Geological Surveying and Mapping (4 to 12), G. Lab. 1 or 2.
M. G. L. 2.	Mining Geological Laboratory (2 to 12), [M. Geol. 2].
M. G. L. 9.	Mining Geological Laboratory (2 to 12), [M. Geol. 9].
M. G. L. 13.	Mining Geological Laboratory (2 to 12), [M. Geol. 13].
M. Lab. 2.	Mining Laboratory and Design (4 to 12), Dr. 2, Mat. 1, Mine 1; [Mine 2 or 4].

M. Lab. 11.	Mine Hoisting and Haulage (4 to 12), [Mine 15].
M. Lab. 12.	Mine Gases, Ventilation, Lighting, etc. (4 to 12), [Mine 2].

SECOND SEMESTER.

I. MINING ENGINEERING.

Class Room Work, (Required 11 Periods).

M. Geol. 3.	Metallites or Metalliferous Deposits (3), Geol. 6, M. Geol. 1.
Mine 3.	Mine Calculations and Estimates (2), Mine 1, 2, 4.
Mine 5.	Coal Mining (2), Mine 4, [Mine 3].
Mchs. 3.	Engineering Materials (1-3) Mchs. 2, [Mchs. 4].
Mine 8.	Hydraulic Mining and Dredging (2), Mine 1, [Mine 3].

Practicums, (Required 3½ Periods).

Hyd. 3 or 9.	Hydraulic Laboratory (4-0 or 2), Hyd. 1.
Mchs. 4.	Testing Materials (0-2), [Mchs. 3].
Met. L. 2.	General Metallurgical Experimentation (4), Ch. 1, 2, Met. 4, Min. L. 7.

Electives, (Required 8½ Periods).

II. MINING.

Class Room Work, (Required 9 Periods).

M. Geol. 3.	Metallites or Metalliferous Deposits (3), Geol. 6, M. Geol. 1.
Mine 3.	Mine Calculations and Estimates (2), Mine 1, 2, 4; [Mine 5].
Mine 5.	Coal Mining (2), Mine 4, [Mine 3].
Mine 8.	Hydraulic Mining and Dredging (2), Mine 1, [Mine 3].

Practicums, (Required 2 Periods).

Met. L. 2.	General Metallurgical Experimentation (4), Ch. 1, 2, Met. 4, Min. L. 7.

Electives, (Required 12 Periods).

III. ENGINEERING GEOLOGY.

Class Room Work, (Required 8 Periods).

Pet. 2.	Microscopical Petrography (3), Pet. 1, Pet. L. 1, [Pet. L. 2].

M. Geol. 3.	Metallites or Metalliferous Deposits (3), Geol. 6, M. Geol. 1.
Mchs. 3.	Engineering Materials (1-3), Mchs. 2, [Mchs. 4].

Practicums, (Required 4½ Periods).

Mchs. 4.	Testing Materials (0-2), [Mchs. 3].
Met. L. 2.	General Metallurgical Experimentation (4), Ch. 1, 2, Met. 4, Min. L. 7.
Pet. L. 2.	Petrographical Laboratory (4), Pet. 1, Pet. L. 1, [Pet. 2].

Electives, (Required 10½ Periods).

IV. MINING GEOLOGY.

Class Room Work, (Required 6 Periods).

Pet. 2.	Microscopical Petrography (3), Pet. 1, Pet. L. 1, [Pet. L. 2].
M. Geol. 3.	Metallites or Metalliferous Deposits (3), M. Geol. 1, Geol. 6.

Practicums, (Required 4 Periods).

Met. L. 2.	General Metallurgical Experimentation (4), Ch. 1, 2, Met. 4, Min. L. 7.
Pet. L. 2.	Microscopical Petrography (4), Pet. 1, Pet. L. 1, [Pet. 2].

Electives, (Required 13 Periods).

V. METALLURGICAL ENGINEERING.

Class Room Work, (Required 2 Periods).

Mchs. 3.	Engineering Materials (1-3), Mchs. 2, [Mchs. 4].

Practicums, (Required 6½ Periods).

Mchs. 4.	Testing Materials (0-2), [Mchs. 3].
Met. L. 19.	Assaying, Fire (6), Met. L. 17, 20.
Met. L. 21.	Assaying of Ores, Slags, Fluxes, and Metallurgical Products (6), Met. L. 20.

Selectives:

Class Room Work, (Required 4 Periods).

Met. 5.	Furnaces, Fuels, Calorimetry, Pyrometry, etc. (3), Met. 4.
Met. 6.	Refractory Materials; their Manufacture, Properties, and Uses (1), Met. 4.

Met. 15.	Alloys; their Properties, Preparation, etc. (1), Met. 4.
Met. 16.	Electro-Metallurgical Processes (3), Met. 4.

Practicums, (Required 2 Periods).

Met. L. 3.	General Metallurgical Experimentation (4), Met. 4, Met. L. 1.
Met. L. 4.	Fuels: Calorimetry, Coking, Physical Tests, and Analyses (4), [Met. 5].
Met. L. 5.	Refractory Materials; their Manufacture and Tests (4), Met. 4, [Met. 6].
Met. L. 11.	Electro-Metallurgical Operations (4), Met. 4, [Met. 16].

Electives, (Required 8½ Periods).

VI. METALLURGY AND ASSAYING.

Practicums, (Required 6 Periods).

Met. L. 19.	Assaying, Fire (6), Met. L. 17.
Met. L. 21.	Assaying of Ores, Slags, Fluxes, and Metallurgical Products (6), Met. L. 20.

Selectives:

Class Room Work, (Required 4 Periods).

Met. 5.	Furnaces, Fuels, Calorimetry, Pyrometry, etc. (3), Met. 4.
Met. 6.	Refractory Materials; their Manufacture, Properties, and Uses (1), Met. 4.
Met. 15.	Alloys; their Properties, Preparation, etc. (1), Met. 4.
Met. 16.	Electro-Metallurgical Processes (3), Met. 4.

Practicums, (Required 2 Periods)

Met. L. 3.	General Metallurgical Experimentation (4), Met. L. 1.
Met. L. 4.	Fluxes ; Calorimetry, Coking, Physical Tests, and Analyses (4),[Met. 5].
Met. L. 5.	Refractory Materials; their Manufacture and Tests (4), Met. 4, [Met. 5].
Met. L. 11.	Electro-Metallurgical Operations (4), Met. 4, Met. L. 1, 17, 20, [Met. 16].

Electives, (Required 11 Periods).

ELECTIVE WORK.

Class Room Work:

En. 11.	English Literature (4), En. 10.

Fr. 6.	French (3), Fr. 3.
Fr. 11.	French (3), Fr. 3.
Ger. 6.	German (3), Ger. 3.
Ger. 9.	German (2), Ger. 3.
Sp. 6.	Spanish (2), Sp. 5.
Lat. 8.	Latin, Plautus and Terence (2), Lat. 7.
Gr. 8.	Greek, Aristophanes and Lucian (2), Gr. 7.
Phy. 4.	Heat (2), Mat. 5.
Phy. 10.	Theory of Light (3), Mat. 5.
Ch. 15.	Physical Chemistry (3).
Bot. 5.	Botany (5), Bot. 3.
Bot. 7.	Bacteriology (3).
Zo. 8.	Zoology (4), Zo. 6.
R. R. 3.	Railroad and Highway Engineering (3), R. R. 2.
R. R. 5.	Highway Engineering (1), R. R. 1.
Str. 1.	Theory of Structures (2), Mchs. 2.
Hyd. 2.	Hydraulic Engineering (2), Mchs. 2, Hyd. 1, Sur. 8 or 10, Ch. 3.
Ht. Eng. 2.	Steam Engines and Boilers (2).
Ht. Eng. 4.	Mechanical Engineering of Power Plants (2), Ht. Eng. 1.
Ht. Eng. 6.	Thermodynamics (3), Ht. Eng. 1, 3, Mat. 5, [Ht. Eng. 5].
E. E. 2.	Dynamo Machinery and Alternating Currents (3), E. E. 1.
E. E. 10.	Electric Transmission of Energy (2), E. E. 9.
Ech. E. 1.	Electro Chemical Engineering (2), Phy. 3, Ch. 5, 6.
Pal 4.	Paleontology (2), Pal. 3, Pal. L. 3, [Pal. L. 4].
Min. 4.	Mathematical Crystallography (2), Min. 3, [Min. L. 14, 15, Pet. 2, Pet. L. 2].
Geol. 10.	Prehistoric Man (2), Geol. 9.
Geol. 13.	Volcanoes and Earthquakes (2), Pet. 1, Pet. L. 1, [Pet. 2, Pet. L. 2].
M. Geol. 5.	Ore Deposits of the United States (2), Mine 1, [M. Geol. 3].
M. Geol. 14.	Petroleum, Natural Gas, Asphaltum, and other Hydrocarbons (2), M. Geol. 1, 2, 13.

Mine 16.	Breaking Ground (Explosives), Boring, and Shaft Sinking (2), Mine 1, 2, 4, [Mine 3, 5, 8].
Ph. 3.	Ethics (3).

Practicums:

Phy. 7 or 8.	Physical Laboratory (2 or 3), Mat. 1.
Ch. 10.	Quantitative Chemical Analysis (8-0 to 12), Ch. 8.
Bot. 6.	Botany (8), Bot. 4, [Bot. 5].
Bot. 8.	Bacteriology (5).
Zo. 9.	Zoology (6), Zo. 7, [Zo. 8].
R. R. 4.	Railroad Surveying and Drawing (4), R. R. 2, [R. R. 3].
M.Des.15 or 16.	Machine Design (4 or 6-4), M. Des. 11 or 12, [M. Des. 13 or 14].
Sh.Pr.29 to 36.	Machine Tool Work (2 to 14), Forging 64 hours.
Str. 2 or 11.	Graphics (4-0 or 2), Mchs. 2, Str. 1.
Ht. Eng. 5.	Steam Laboratory (2), Ht. Eng. 1 and 3.
El. Lab. 6.	Electrical Measurements (4), El. Lab. 1.
El. Lab. 7.	Electrical Engineering Laboratory (2), E. E. 9, [E. E. 10].
Ech. E. Lab. 1.	Electrochemical Engineering Laboratory (6), Phy. 3, Ch. 5, 6.
Min. L. 11.	Mineralogy and Petrography (4 to 12), Min. L. 7.
Min. L. 15.	Crystallographic Laboratory (4 to 12), Min. L. 14, [Min. 4, Pet. 2, Pet. L. 2].
Pet. L. 6.	Petrographical Laboratory (2 to 12), [Pet. L. 2].
Pal. L. 4.	Paleontological Laboratory (4), Pal. 3, Pal. L. 3, [Pal. 4].
Pal. L. 14.	Paleontological Laboratory (2 to 12), [Pal. L. 4].
G. Lab. 6.	Field Geology and Geological Surveying and Mapping, (4 to 12), G. Lab. 1 or 2.
M. G. L. 3.	Mining Geological Laboratory (2 to 12), [M. Geol. 3].
M. G. L. 5.	Mining Geological Laboratory (2 to 12), [M. Geol. 5].
M. G. L. 14.	Mining Geological Laboratory (2 to 12) [M. Geol. 14].

M. Lab. 3.	Mining Laboratory and Design (4 to 12), [Mine 3, or 5, or 8].
M. Lab. 13.	Breaking Ground (Explosives), Boring, and Shaft Sinking (4 to 12), [Mine 16].

SUMMER SCHOOL. ELECTIVE WORK.

Practicums, (Required 100 hours or 3 Periods).

Ch. 22.	Quantitative Chemical Analysis (100 hours).
Met. L. 28.	Metallurgical Inspection Trip (100 hours), Met. 4.
Pet. L. 11.	Petrographical Field Work (100 hours), Pet. 2, Pet. L. 2.
G. Lab. 10.	Geological Field Work (100 hours), Geol. 6, G. Lab. 9.
M. Lab. 19.	Mining and Mining Methods (100 hours), Mine 1, 2, 3 4, 5; Mine L. 18.
M. G. L. 24.	Field Work in Mining Geology (100 hours), M. Geol. 1, 2, 3, 9, 10.

SUMMER VACATION. ELECTIVE WORK.

Practicums, (16 Periods).

Met L. 24.	Practical Work in Metallurgy (10 weeks), Met. 4, Met. L. 1 or 4.
Met. L. 26.	Practical Work in Assaying (10 weeks), Met. L. 17.
Min. L. 23.	Practical Work in Mineralogy (10 weeks), Min. L. 7.
Pet. L. 13.	Petrographical Field Work (10 weeks), Pet. 2, Pet. L. 2.
G. Lab. 13.	Practical Work in Geology (10 weeks), Geol. 6, G. Lab. 1 or 2.
Pal. L. 22.	Practical Work in Paleontology (10 weeks), Pal. L. 1, 2.
M. G. L. 27.	Practical Work in Mining Geology (10 weeks), M. Geol. 1, 2, 3, 9, 10.
M. Lab. 24.	Practical Work in Mining (10 weeks), Mine 1, 2, 3, 4, 5.

SENIOR YEAR.

FIRST SEMESTER.

Class Room Work, (Required 5 Periods).

Law. 3.	Principles of Law and Law of Contracts (2), M. Geol. 1, Mine 1.
Law. 4.	Mining Law and Law of Mining Injuries (3), M. Geol. 1, Mine 1, [Law 3].

OPTIONS.

I. MINING ENGINEERING.

Class Room Work, (Required 7 Periods).

Mine 6.	Metal Mining (2), Mine 1, 2, 3, 4, 5; [Mine L. 4].
Mine 9.	Mining Engineering (3), Mchs. 2, 3, Hyd. 1, Mine 1, 2, 3, 4, 5; [Mine 6, M. Lab. 4].
Ore. 1.	Principles of Ore Dressing and Coal Washing (2), Met. 4, Min. L. 7.

Practicums, (Required 3 Periods).

M. Lab. 4.	Mining Laboratory and Design (6), Dr. 2, Mat. 1, Mine 1, 2, 3 4, 5, [Mine 6].

Electives, (Required 8 Periods).

II. MINING.

Class Room Work, (Required 6 Periods).

Mine 6.	Metal Mining (2), Mine 1, 2, 3, 4, 5, [Mine L. 4].
Mine 12.	Mining and Ventilating Machinery (2), Mine 1, 2, 3, 4, 5, [Mine 6].
Ore. 1.	Principles of Ore Dressing and Coal Washing (2), Met. 4, Min. L. 7.

Practicums, (Required 3 Periods).

M. Lab. 4.	Mining Laboratory and Design (6), Dr. 2, Mat. 1; Mine 1, 2, 3, 4, 5; [Mine 6].

Electives, (Required 9 Periods).

III. ENGINEERING GEOLOGY.

Class Room Work, (Required 5 Periods).

Pet. 3.	Origin of Minerals, Rocks, and Ore Deposits-their Alterations, Relations and Classifications (3), Pet. 2, Pet. L. 2, [Pet. L. 3].
Ore. 1.	Principles of Ore Dressing and Coal Washing (2), Met. 4, Min. L. 7.

Practicum, (Required 2 Periods).

Pet. L. 3.	Petrographical Laboratory (4), Pet. 2, Pet. L. 2, [Pet. 3].

Electives, (Required 11 Periods).

IV. MINING GEOLOGY.

Class Room Work, (Required 5 Periods).

Ore. 1.	Principles of Ore Dressing and Coal Washing (2), Met. 4, Min. L. 7.
Pet. 3.	Origin of Minerals, Rocks and Ore Deposits—their Alterations, Relations, and Classifications (3), Pet. 2, Pet. L. 2, [Pet. L. 3].

Practicums, (Required 2 Periods).

Pet. L. 3.	Petrographical Laboratory (4), Pet. 2, Pet. L. 2, [Pet. 3].

Electives, (Required 11 Periods).

V. METALLURGICAL ENGINEERING.

Class Room Work, (Required 4 Periods).

Ore. 2.	Ore Dressing Operations and Machinery (2), Met. 4, Met. L. 7.
Ore. 3.	Coal Washing and Preparation for Market (2), Met. 4, Met. L. 7.

Practicums, (Required 3½ Periods).

Met. L. 14.	Metallurgical Designing (4), Met. 4, Dr. 2, Met L. 1 or 2.
Met. L. 16.	Metallurgical Calculations (3), Met. 4, Met L. 1.

Selectives:

Class Room Work, (Required 4 Periods).

Met. 7.	Gas Producers (2), Met. 4.
Met. 8.	Metallography—the Microscopic Structure of Metals and Alloys (1), Met. 4.
Met. 9.	Blast Furnaces, Foundry Work, Cast Iron, etc. (3), Met. 4.
Met. 11.	The Metallurgy of Copper (2), Met. 4.
Met. 12.	The Metallurgy of Lead (2), Met. 4.

Practicums:

Metallurgical Practicum, (Required 2 Periods).

Met. L. 6.	Metallography — Polishing, Etching, Microscopic Study, Microphotography, and the Effects of Heat Treatment and Mechanical

	Treatment on Metals and Alloys (4), [Met. 8].
Met. L. 7.	Experiments with Iron and Steel (4), Ch. 5, 6, [Met. 9].
Met. L. 9.	Experiments in Smelting and Refining (4), Ch. 5, 6, [Met. 10 or 11].

Ore Dressing Practicum, (Required 3 Periods).

Ore L. 1.	Ore Dressing Machinery (6), Met. L. 1 or 2 and 17, Met. 4, [Ore 1 or 2].
Ore L. 2.	Coal Washing and Preparation for Market (6), Met. 4, Met. L. 1 or 2, [Ore 3].

Electives, (Required 1½ Periods).

VI. METALLURGY AND ASSAYING.

Class Room Work, (Required 4 Periods).

Ore 2.	Ore Dressing Operations and Machinery (2), Met. 4, Met. L. 7.
Ore 3.	Coal Washing and Preparation for Market (2), Met. 4, Met. L. 7.

Practicums, (Required 3½ Periods).

Met. L. 14.	Metallurgical Designing (4), Met. 4, Dr. 2, Met. L. 1 or 2.
Met. L. 16.	Metallurgical Calculations (3), Met. 4, Met. L. 1.

Selectives:

Class Room Work, (Required 4 Periods).

Met. 7.	Gas Producers (2), Met. 4.
Met. 8.	Metallography—the Microscopic Structure of Metals and Alloys (1), Met. 4.
Met. 9.	Blast Furnaces, Foundry Work, Cast Iron, etc. (3), Met. 4.
Met. 11.	The Metallurgy of Copper (2), Met. 4.
Met. 12.	The Metallurgy of Lead (2), Met. 4.

Practicums:

Metallurgical Practicum, (Required 2 Periods).

Met. L. 6.	Metallography — Polishing, Etching, Microscopic Study, Microphotography, and the Effects of Heat Treatment and Mechanical Treatment on Metals and Alloys (4), [Met. 8].
Met. L. 7.	Experiments with Iron and Steel (4), Ch. 5, 6, [Met. 9].

Met. L. 9.	Experiments in Smelting and Refining (4), Ch. 5, 6; Met. 4, Met. L. 17, [Met. 10 or 11].

Ore Dressing Practicum, (Required 3 Periods).

Ore L. 1.	Ore Dressing Machinery (6), Met. L. 1 or 2, and 17, Met. 4, [Ore 1 or 2].
Ore L. 2.	Coal Washing and Preparation for Market (6), Met. 4, Met. L. 1 or 2, [Ore 3].

Electives, (Required 1½ Periods).

ELECTIVE WORK.

Class Room Work:

En. 13.	English Literature (2), En. 11.
Fr. 12.	French (2), Fr. 4.
Ger. 10.	German (2), Ger. 6.
Sp. 7.	Spanish (2), Sp. 6.
Lat. 9.	Latin, Cicero and Quintilian (2), Lat. 8.
Ger. 9.	Greek, Demosthenes and Isocrates, Gr. 8.
Mat. 12.	Analytic Mechanics (3 or 4), Mat. 11.
Mat. 13.	Analytic Mechanics (3), Mat. 5.
Mat. 14.	Least Squares (2), Mat. 5.
Ch. 19.	Industrial Chemistry (2).
Str. 3.	Bridges and Roofs (3), Str. 1 and 2 or 11.
Hyd. 5.	Sanitary Engineering (2), Hyd. 2.
Ht. Eng. 8.	Thermodynamics (2), Ht. Eng. 2, [Ht. Eng. 9].
Ht. Eng. 12.	Gas Engines, Steam Turbines, Refrigerating and Air Machinery (5), [Ht. Eng. 6].
Ht. Eng. 13.	Heating and Ventilating (2).
R. M. E. 1.	Locomotives (2), Ht. Eng. 1, 3, 6.
E E. 3.	Alternating Currents and Alternating Current Machinery (3), E. E. 2.
Ech. E. 2.	Electrochemical Engineering (2), Ech. E. 1, [Ech. E. Lab. 2].
Ech. E. 5.	Electro Metallurgy (1), Phy. 3, Ch. 5, 6, [Ech. E. Lab. 5].
Pal. 5.	Paleobotany (2), Geol. 7, 8; Pal. 1, 2; Pal. L. 1, 2; [Pal. L. 5].
Min. 5.	Physical and Chemical Mineralogy (2), Min. 4, Min. L. 15, [Min. L. 16, Pet. 3, Pet. L. 3].
Geol. 11.	Geology of the United States (2), Geol. 6, 7, 8, Min. L. 7.

M. Geol. 4.	Metallites or Metalliferous Deposits, continued (2), M. Geol. 3.
M. Geol. 10.	Precious Stones or Gems (2), M. Geol. 2, 9, Min. L. 7, Pet. 2, Pet. L. 2, [Pet. 3, Pet. L. 3].
M. Geol. 11.	Clays—their Occurrence, Properties, and Uses (2), Min. L. 7, M. Geol. 2, Pet. 2, Pet. L. 2, [Pet. 3, Pet. L. 3].
M. Geol. 17.	Iron Ores (2), M. Geol. 1, 3, M. Geol. 4, [Pet. 3, Pet. L. 3].
Mine 17.	Exploitation and Supporting, including Timbering (2), Mine 16, [Mine 6].
Ph. 4.	Lectures on Modern Education (3).
Ph. 5.	Greek and Mediaeval Philosophy (4).
Pol. 1.	Political Economy (4).
Law 1.	Constitutional Law (4).
Law 5.	Law relating to Oil and Gas (2),[Law 3, 4].

Practicums:

Ch. 11.	Quantitative Chemical Analysis (8-0 to 12) Ch. 10.
Str. 4.	Structural Design (8), Str. 1, and 2 or 11, [Str. 3].
Ht. Eng. 9.	Steam Engine and Boiler Tests (2), Ht. Eng. 2, [Ht. Eng. 8].
Ech. E. Lab.2.	Electrochemical Engineering Laboratory (6), Ech. E. Lab. 1, [Ech. E. 2].
Ech. E. Lab. 4.	Electrochemical Analysis (4), Phy. 3, Ch. 5, 6.
Ech. E. Lab.5.	Electrochemical Engineering Laboratory (4), Phy. 3, Ch. 5, 6, [Ech. E. 5].
Met. L. 12.	Research Work in Metallurgy or Assaying (4 to 12), Met. L. 1, and at least 8 hours of other Metallurgical Laboratory work.
Met. L. 22.	Assaying of Ores, Slags, Fluxes and Metallurgical Products (6), Met. L. 21.
Min. L. 12.	Mineralogy and Petrography (4 to 12), Min. L. 7.
Min. L. 16.	Physical and Chemical Mineralogy (4 to 12), [Min. 5, Pet. 3, Pet. L. 3].
Pet. L. 7.	Petrographical Laboratory (2 to 12), [Pet. L. 3].

Pal. L. 5.	Paleobotanical Laboratory (4), Geol. 7, 8; [Pal. 5].
Pal. L. 15.	Paleontological Laboratory (4 to 12), Pal. L. 4.
G. Lab. 7.	Field Geology and Geological Surveying, and Mapping (4 to 12), G. Lab. 5 or 6.
M. G. L. 4.	Mining Geological Laboratory (2 to 12), [M. Geol. 4].
M. G. L. 10.	Mining Geological Laboratory (2 to 12), [M. Geol. 10].
M. G. L. 11.	Mining Geological Laboratory (2 to 12), [M. Geol. 11].
M. G. L. 17.	Mining Geological Laboratory (2 to 12), [M. Geol. 17].
M. Lab. 6.	Mining Laboratory and Design (2 to 12), [M. Lab. 5].
M. Lab. 8.	Mining and Ventilating Machinery (4 to 12), [Mine 6, 12].
M. Lab. 14.	Exploitation and Supporting, including Timbering (4 to 12), [Mine 17].

SECOND SEMESTER.

Class Room Work, (Required 5 Periods).

Mine 11.	Mine Sampling, Valuation, Economics, Accidents, First Aid to the Injured, etc. (2), Mine 1, M. Geol. 1.
Mine 21.	Mine Economics, Labor, Management, etc. (3), M. Geol. 1, Mine 1, Law 3, 4, [Mine 11].

I. MINING ENGINEERING.

Class Room Work, (Required 7 Periods).

Mine 7.	Metal Mining (2), Mine 6, [M. Lab. 5].
Mine 10.	Mining Engineering (3), Mine 9, [Mine 7, 13, M. Lab. 5].
Mine 13.	Power Generation and Transmission in Mines (2), Mine 6, [Mine 7].

Practicum, (Required 3 Periods).

M. Lab. 5.	Mining Laboratory and Design (6), M. Lab. 4, [Mine 7].

Electives, (Required 8 Periods).

II. MINING.

Class Room Work, (Required 6 Periods).

Mine 7.	Metal Mining (2), Mine 6, [M. Lab. 5].

Mine 13.	Power Generation and Transmission in Mines (2), Mine 6, [Mine 7].
Mine 14.	Mine Drainage and Pumping (2), Mine 6, [Mine 7, 13].

Practicum, (Required 3 Periods).

M. Lab. 5.	Mining Laboratory and Design (6), M. Lab. 4, [Mine 7].

Electives, (Required 9 Periods).

III. ENGINEERING GEOLOGY.

Class Room Work, (Required 5 Periods).

Geol. 14.	Azoic or Archean Geology (2), Pet. 3, Pet. L. 3, Geol. 6, [Pet. 4, Pet. L. 4].
Pet. 4.	Origin of Minerals, Rocks and Ore Deposits—their Alterations, Relations, and Classifications (3), Geol. 6, Pet. 3, Pet. L. 3, [Pet. L. 4].

Practicum, (Required 2 Periods).

Pet. L. 4.	Petrographical Laboratory (4), Pet. 3, Pet. L. 3, [Pet. 4].

Electives, (11 Periods).

IV. MINING GEOLOGY.

Class Room Work, (Required 5 Periods).

Geol. 14.	Azoic or Archean Geology (2), Geol. 6, Pet. 3, Pet. L. 3, [Pet. 4, Pet. L. 4].
Pet. 4.	Origin of Minerals, Rocks and Ore Deposits—their Alterations, Relations, and Classifications (3), Geol. 6, Pet. 3, Pet. L. 3, [Pet. L. 4].

Practicum, (Required 2 Periods).

Pet. L. 4.	Petrographical Laboratory (4), Pet. 3, Pet. L. 3, [Pet. 4].

Electives, (Required 11 Periods).

V. METALLURGICAL ENGINEERING.

Class Room Work, (Required 4 Periods).

Ore 4.	The Milling of Gold and Silver Ores (2), Ore 1 or 2.

Ore 5.	Hydro-Metallurgy—the Cyanide, Chlorination, Hyposulphite, and other Leaching Processes (2), Ore 1 or 2.

Selectives:

Class Room Work, (Required 4 Periods).

Met. 10.	Steel—its Methods of Manufacture, Properties, Heat Treatment, and Methods of Working (4), Met. 9.
Met. 13.	Metallurgy of Gold and Silver (2), Met. 4, Ore 1 or 2.
Met. 14.	Metallurgy of Zinc, Tin, Antimony, Bismuth, Nickel, etc. (2), Met. 4.

Practicums, (Required 2 Periods).

Met. L. 8.	Experiments with Iron and Steel (4), Met. L. 7, [Met. 10].
Met. L. 10.	Experiments in Smelting and Refining (4), Met. L. 9, [Met. 13 or 14].

Electives, (Required 8 Periods).

VI. METALLURGY AND ASSAYING.

Class Room Work, (Required 4 Periods).

Ore 4.	The Milling of Gold and Silver Ores (2), Ore 1 or 2.
Ore 5.	Hydro-Metallurgy—the Cyanide, Chlorination, Hyposulphite, and other Leaching Processes (2), Ore 1 or 2.

Selectives:

Class Room Work, (Required 4 Periods).

Met. 10.	Steel—its Methods, Manufacture, Properties, Heat Treatment, and Methods of Working (4), Met. 9.
Met. 13.	Metallurgy of Gold and Silver (2), Met. 4.
Met. 14.	Metallurgy of Zinc, Tin, Antimony, Bismuth, Nickel, etc. (2), Met. 4.

Practicums, (Required 2 Periods).

Met. L. 8.	Experiments with Iron and Steel (4), Met. L. 7, [Met. 10].
Met. L. 10.	Experiments in Smelting and Refining (4), Met. L. 9, [Met. 13 or 14].

Electives, (Required 8 Periods).

ELECTIVE WORK.

Class Room Work:

En. 14.	English Literature (2) En. 13.
Fr. 13.	French (2) Fr. 12.
Ger. 12.	German (2) Ger. 10.
Sp. 8.	Spanish (2) Sp. 7.
Lat. 10.	Latin, Cicero (2), Lat. 9.
Gr. 10.	Greek, Plato and the New Testament (2), Gr. 9.
Mat. 18.	Astronomy (4), Mat. 1.
Bot. 9.	Botany (5), Bot. 5.
Zo. 9.	Zoology (5), Zo. 8.
Str. 5.	Masonry Structures (2), Str. 2, Mchs. 2.
Str. 6.	Masonry Structures (2-0), Mchs. 2.
Ht. Eng. 14.	Gas Engines (2), Ht. Eng. 12.
E. E. 10.	Electric Transmission of Energy (2), E. E. 9.
E. E. 11.	Electricity in Mines (1), E. E. 3.
Ech. E. 3.	Electrochemical Engineering (4), Ech. E. 2, [Ech. Lab. 3].
Ech. E. 4.	Primary and Secondary Batteries (2), E. E. 1.
Min. 6.	Physical and Chemical Mineralogy (2), Min. 5, Min. L. 16, Pet. 3, Pet. L. 3, [Min. L. 17, Pet. 4, Pet. L. 4].
Pal. 6.	Paleobotany (2), Pal. 5, Pal. L. 5, [Pal. L. 6].
Geol. 12.	Geology of Pennsylvania (2), Geol. 11.
M. Geol. 12.	Limes, Mortars, Plasters, Cements, etc. (2), M. Geol. 11, Pet. 3, Pet. L. 3; [Pet. 4, Pet. L. 4].
M. Geol. 18.	Copper Deposits (2), M. Geol. 5, 17, Pet. 3, Pet. L. 3, [Pet. 4, Pet. L. 4].
M. Geol. 22.	The Theory of Ore Deposits (2), M. Geol. 3, Pet. 3, Pet. L. 3, [Pet. 4, Pet. L. 4].
Mine 18.	Advanced Mine Surveying (1), Sur. 9, 10, [M. Lab. 15].
Ph. 6.	Modern Philosophy (4), Ph. 5.
Law 1.	Constitutional Law, continued (4).
Law 2.	International Law (4).
Law 6.	Mining Law (3), Law 3, 4.
Law 7.	Law of Negligence and of Personal Injuries in Mines (2), Law 3, 4.

Practicums:

Ch. 12.	Quantitative Chemical Analysis (8-0 to 12), Ch. 11.

Bot. 10.	Botany (8), [Bot. 9].
Zo. 10.	Zoology (8), [Zo. 9].
Str. 7.	Masonry Tests (2-0) Mchs. 2, [Str. 5 or 6].
Str. 8 or 9.	Structural Design [6-8 or 4-6], Str. 4.
Hyd. 12.	Hydraulic Machinery (2), Mchs. 2.
El. Lab. 9.	Electrical Engineering Laboratory (0-2), E. E. 9, [E. E. 10].
Ech. E. Lab. 3.	Electrochemical Engineering Laboratory (4), Ech. E. Lab. 2, Ech. E. 3.
Met. L. 13.	Research Work in Metallurgy or Assaying (4 to 12). Same as Met. L. 12.
Met. L. 15.	Metallurgical Designing (4), Met. L. 14.
Met. L. 23.	Assaying of Ores, Slags, Fluxes, and Metallurgical Products (6), Met. L. 22.
Ore L. 3.	Gold and Silver Milling (6), Ore 2, Met. 4, Met. L. 1 or 2 and 17, [Ore 4].
Ore L. 4.	Hydrometallurgy of Gold, Silver, etc. (6), Met. L. 1 or 2 and 17, Ore 2, Met. 3, [Ore 5].
Min. L. 13.	Mineralogy and Petrography (4 to 12), Min. L. 7.
Min. L. 17.	Physical and Chemical Mineralogy (4 to 12), [Min. 6, Pet. 4, Pet. L. 4.]
Pet. L. 8.	Petrographical Laboratory (2 to 12), [Pet. L. 4].
Pal. L. 6.	Paleobotanical Laboratory (4), Pal. L. 5, [Pal. 6].
Pal. L. 16.	Paleontology (4 to 12), Pal. L. 4.
G. Lab. 8.	Field Geology and Geological Surveying and Mapping (4 to 12), G. Lab. 5 or 6.
M. G. L. 12.	Mining Geological Laboratory (2 to 12), [M. Geol. 12.]
M. G. L. 18.	Mining Geological Laboratory (2 to 12), [M. Geol. 18].
M. G. L. 22.	Mining Geological Laboratory (2 to 12), [M. Geol. 22].
M. Lab. 7.	Mining Laboratory and Design (2 to 12), [M. Lab. 5].
M. Lab. 19.	Power Generation and Transmission in Mines (4 to 12), [Mine 7, 13].
M. Lab. 10.	Mine Drainage and Pumping (4 to 12), [Mine 14].
M. Lab. 15.	Advanced Mining Surveying (4), Sur. 9, 10, [Mine 18].

SUMMER SCHOOL. ELECTIVE WORK.

G. Lab. 11.	Geological Field Work (100 hours), Geol. 6, G. Lab. 1 or 2.
M. Lab. 20.	Mining and Mining Methods (100 hours), M. Lab. 18.
M. G. L. 25.	Field Work in Mining Geology (100 hours), M. Geol. 1, 2, 3, 9, 10, 11, 12.
Pet. L. 12.	Petrographical Field Work (100 hours), Pet. 4, Pet. L. 4.

SUMMER VACATION. ELECTIVE WORK.

Practicum, (16 Periods).

Met. L. 25.	Practical Work in Metallurgy (10 weeks), Completion of the Required Work in Metallurgy.
Met. L. 26.	Practical Work in Assaying (10 weeks), Met. L. 17.
Ore L. 5.	Practical Work in Ore Dressing (10 weeks), Ore 1 or 2.
Ore L. 6.	Practical Work in Coal Washing (10 weeks), Ore 1 or 2.
Min. L. 24.	Practical Work in Mineralogy (10 weeks), Min. L. 7.
Pet. L. 14.	Petrographical Field Work (10 weeks), Pet. 4, Pet. L. 4.
G. Lab. 14.	Practical Work in Geology (10 weeks), Geol. 6, G. Lab. 1 or 2.
Pal. L. 23.	Practical Work in Paleontology (10 weeks), Pal. L. 1, 2.
M. G. L. 28.	Field Work in Mining Geology (10 weeks), M. Geol. 1, 2, 5, 9, 10, 11, 12, 22.
M. Lab. 25.	Practical Work in Mining (10 weeks), Mine 6, 7.

GRADUATE WORK.

FIRST SEMESTER.

Class Room Work:

Min. 7.	Physical and Chemical Mineralogy (2), Min. 6, Min. L. 17, Pet. 4, Pet. L. 4, [Min. L. 18].
Min. 9.	Mineralogy of the United States (2), Min. 6, Pet. 4, Pet. L. 4, [Min. 7].
Pal. 7.	Paleobotany (2), Pal. 6, Pal. L. 6.
Pal. 9.	Paleontology (2), Pal. 4, Pal. L. 4.

Geol. 15.	History of Geology and Paleontology (2), Geol. 6, 7, 8, 13, 14; Pet. 1, 2, 3, 4; Pet. L. 1, 2, 3, 4.
Geol. 16.	The Philosophy of Geology (2), Geol. 6, 7, 8, 13, 14; Pet. 1, 2, 3, 4; Pet. L. 1, 2, 3, 4; [Geol. 15].
Geol. 18.	Physical and Chemical Geology (2), Geol. 6, 13, 14, Pet. 1, 2, 3, 4; Pet. L. 1, 2, 3, 4.
Mine 19.	Deep Mining (2), Mine 9, 10, 12, 13, 14, 15, 16, 17.
M. Geol. 6.	Ore Deposits of Europe (2), M. Geol. 5, 22.
M. Geol. 8.	Mining Geology of Pennsylvania (2), M. Geol. 2, 5, 22.
M. Geol. 16.	Waters, Salines, Pigments, and Mineral Medicines (2), M. Geol. 1, 2, 9, 11, 22.
M. Geol. 20.	Tin, Lead, Zinc, and Mercury Deposits (2), M. Geol. 3, 18, 22.
Law 8.	Introduction to American Law and the Law of Contracts, Limitations, and Frauds as Applied to Mining (3), Law 3, 4, 5, 6, 7.
Law 10.	Mining Laws of Great Britain (3), Law 3, 4, 5, 6, 7.
Practicums:	
Met. L. 29.	Research Work in Metallurgy (4 to 12), Met. L. 12 or 13.
Met. L. 31.	Research Work in Assaying (4 to 12), Met. L. 19, 23.
Min. L. 18.	Physical and Chemical Mineralogy (4 to 12), Pet. 4, Pet. L. 4, [Min. 7].
Min. L. 20.	Research Work in Mineralogy (4 to 12), Pet. 4, Pet L. 4, [Min. L. 18].
Pet. L. 9.	Petrographical Research (4 to 12), Pet. 4, Pet. L. 4.
Pal. L. 7.	Paleobotanical Laboratory (4), Pal. L. 6, [Pal. 7].
Pal. L. 9.	Paleontological Laboratory (4), Pal. 4, Pal. L. 4, [Pal. 9].
Pal. L. 17.	Paleontological Laboratory (2 to 12), [Pal. L. 9].
Pal. L. 19.	Paleobotanical Laboratory (2 to 12), [Pal. L. 7].
M. G. L. 6.	Mining Geological Laboratory (2 to 12), [M. Geol. 6].

M. G. L. 8.	Mining Geological Laboratory (2 to 12), [M. Geol. 8].
M. G. L. 16.	Mining Geological Laboratory (2 to 12), [M. Geol. 16].
M. G. L. 20.	Mining Geological Laboratory (2 to 12), [M. Geol. 20].
M. Lab. 16.	Deep Mining (4 to 12), [Mine 19].

SECOND SEMESTER.

Class Room Work:

Min. 8.	Physical and Chemical Mineralogy (2), Pet. 4, Pet. L. 4, Min. 7, Min. L. 18, [Min. L. 19].
Min. 10.	Mineralogy of Pennsylvania (2), Min. 9, [Min. 8].
Pal. 8.	Paleobotany (2), Pal. 7.
Pal. 10.	Paleontology (2), Pal. 9.
Geol. 17.	The Philosophy of Geology (2), Geol. 16.
Geol. 19.	Physical and Chemical Geology (2), Geol. 18.
M. Geol. 7.	Ore Deposits of Asia, Australasia, Africa, and South America (2), M. Geol. 6, 22.
M. Geol. 15.	Road and Refractory Materials, Abrasives, Fluxes, Phosphates, etc. (2), M. Geol. 1, 2, 9, 11, 12, 22, Pet. 4, Pet. L. 4.
M. Geol. 19.	Ores of Gold, Silver, and Silver Lead (2), M. Geol. 18, 20, 22.
M. Geol. 21.	Ores of Aluminum, Manganese, Mercury, Chromium, Nickel, Cobalt, Platinum, etc. (2), M. Geol. 18, 20.
Mine 20.	Advanced Mining Engineering (2), Mine 19.
Law 9.	The Law of Engineering Operations (3), Law 3, 4, 5, 6, 7, 8.
Law 11.	Mining Laws of Mexico and Other Foreign Countries (2), Law 3, 4, 5, 6, 7, 8, 10.

Practicums:

Met. L. 30.	Research Work in Metallurgy (4 to 12), Met. L. 29.
Met. L. 32.	Research Work in Assaying (4 to 12), Met. L. 31.
Min. L. 19.	Physical and Chemical Mineralogy (4 to 12), [Min. 8].
Min. L. 21.	Research Work in Mineralogy (4 to 12), [Min. L. 19].

Pet. L. 10.	Petrographical Research (4 to 12), Pet. 4, Pet. L. 4, 9.
Pal. L. 8.	Paleobotanical Laboratory (4), Pal. L. 7, [Pal. 8].
Pal. L. 10.	Paleontological Laboratory (4), Pal. 9, Pal. L. 9, [Pal. 10].
Pal. L. 18.	Paleontological Laboratory (2 to 12), [Pal. L. 10].
Pal. L. 20.	Paleobotanical Laboratory (2 to 12), [Pal. L. 8].
M. G. L. 7.	Mining Geological Laboratory (2 to 12), [M. Geol. 7].
M. G. L. 15.	Mining Geological Laboratory (2 to 12), [M. Geol. 15].
M. G. L. 19.	Mining Geological Laboratory (2 to 12), [M. Geol. 19].
M. G. L. 21.	Mining Geological Laboratory (2 to 12), [M. Geol. 21].
M. Lab. 17.	Advanced Mining Engineering (4 to 12), [Mine. 19].

GRADUATE WORK. SUMMER VACATION.

Met. L. 33.	Practical Work in Metallurgy (10 weeks), Met. L. 30.
Met. L. 34.	Practical Work in Assaying (10 weeks), Met. L. 32.
Ore L. 7.	Practical Work in Ore Dressing (10 weeks), Ore L. 1.
Ore L. 8.	Practical Work in Coal Washing (10 weeks), Ore L. 2.
Min. L. 25.	Practical Work in Mineralogy (10 weeks), Min. L. 7.
Pet. L. 15.	Petrographical Field Work (10 weeks), Pet. 4, Pet. L. 4.
Pal. L. 24.	Practical Work in Paleontology (10 weeks).
G. Lab. 15.	Practical Work in Geology, Geol. 16, 17, or 18, 19; G. Lab. 1 or 2.
M. G. L. 29.	Practical Work in Mining Geology (10 weeks), M. Geol. 5.
M. Lab. 26.	Practical Work in Mining (10 weeks), Mine 19, 20.

WORK IN THE SCHOOL OF MINES AND METALLURGY

THE work offered in the School of Mines and Metallurgy is described more or less in detail in the following pages. The subjects are arranged in groups, to which reference is made in the schedules of studies under the following abbreviations:

	Group Name	Reference Abbreviation
1.	Geology	Geol.
2.	Geological Laboratory	G. Lab.
3.	Metallurgy	Met.
4.	Metallurgical Laboratory	Met. L.
5.	Mineralogy	Min.
6.	Mineralogical Laboratory	Min. L.
7.	Mining	Mine.
8.	Mining Laboratory	M. Lab.
9.	Mining Geology	M. Geol.
10.	Mining Geological Laboratory	M. G. L.
11.	Mining Law	Law.
12.	Ore Dressing and Coal Washing	Ore.
13.	Ore Dressing Laboratory	Ore. L.
14.	Paleontology	Pal.
15.	Paleontological Laboratory	Pal. L.
16.	Petrography	Pet.
17.	Petrographical Laboratory	Pet. L.

Subjects taught in the class rooms and laboratories of other schools, belonging to this College, will be found described under the respective departments to which they belong.

GEOLOGY.

The courses in Geology are especially adapted to the needs of the prospector, the explorer, the teacher, the engineer, the petrographer, the geologist, the miner, the quarryman and all others who desire to understand the connection and the structural relations that rock-masses bear to one another and to the valuable deposits that they contain. The courses treat of the origin and alteration of rocks, of volcanic and earthquake action, sedimentation, metamorphism, jointing, faulting, cleavage, mountain building, eruptive rocks, and crystalline schists; the action of air, surface and underground waters, and life especially in their relations to the problems that the mining geologist, miner, and quarryman have to meet. The student has brought before him constantly the various problems that arise in practical work and the methods of their solution.

These courses enlarge upon and complete much that is more briefly touched upon in Mineralogy and Petrography. The instruction is given by lectures, and by recitations based upon the lectures and upon various text books.

Geol. 1. **The Principles of Geology.**

Under this head instruction is given by means of text-books and lectures on the general principles of geological science, including the probable origin and structure of the earth; volcanic and earthquake action; the destructive and reconstructive action of air and water, both surface and subterranean; the important earth-building minerals and rocks, and their alterations and accidents; life and its order of succession on this globe; the origin and mode of occurrence of the useful geological deposits, etc.

Text-books: *Elements of Geology*, Norton; *Economic Geology of the United States*, Ries.

Gen. Sci., Class., Lang., Lat. Sci., Phil., Agr.
Biol., Chem., For.

Junior and Senior Years, First Semester, 3 hours.

Geol. 2. **Engineering Geology.**

Preparation required: Min L. 2.

This course is intended to give to the student the general ideas of Geology and their applications to field and engineering practice.

The instruction will be based upon the preceding laboratory work in Mineralogy and Petrography. It is intended to take up briefly the general principles of Geology, continue the study of the rocks, and take up the applications of geological principles to geological surveying and mapping and to economic deposits.

Text-books: *Elements of Geology,* Norton; *Economic Geology of the United States,* Ries.

C. E. Senior Year, First Semester, 3 hours.

Geol. 3. **Elements of Physical Geography.**

Preparation required: Geol. 1.

For. Sophomore Year, First Semester, 2 hours.

Geol. 4. **Advanced Physical Geography.**

Preparation required: Geol. 3 or 6.

Elect. Sophomore Year, Second Semester, 2 hours.

Geol. 5. **Advanced Physical Geography, Continued.**

Preparation required: Geol. 4, 6, G. Lab. 1, Min L. 7.

The work in Physical Geography will cover the general principles of the subject, especially earth sculpture and the action of the forces at work to modify the earth's surface and their effects upon various industries.

Text-books: There will be used, as required, books similar to the following: *Text-book of Elementary Physical Geography,* Davis; *Introduction to Physical Geography,* Gilbert and Brigham; *Earth Sculpture,* Geikie; *Geology, Vol. 1, Geologic Processes and their Results,* Chamberlin and Salisbury; *Elementary Meteorology,* Davis; *Practical Physiography,* Fairbanks; *Physiography,* Salisbury; *Glaciers, Rivers, Lakes, and Volcanoes of North America,* Russell; etc.

Elect. Junior Year, First Semester, 2 hours.

Geol. 6. **General and Field Geology.**

Preparation required: Min. L. 7, or
Taken with Min. L. 7.

This course is intended to cover the general principles of Geology, geological agencies and their applications in Physical, Chemical, Stratigraphical and Field Geology. It will further discuss the earth's structure, the methods of geological surveying, and the making of geological maps and sections.

Text-books: *Introduction to Geology,* Scott; *Structural and Field Geology,* Geikie, and *Outlines of Field Geology,* Geikie.

E. M., Mine., E. Geol., M. Geol., E. Met., Met.
Sophomore Year, First Semester, 3 hours.

Geol. 7. **Paleozoic Geology.**

Taken with Geol. 6, Min. L. 7, G. Lab. 1, Pal. 1, Pal. L. 1.

This course is intended to give the student a fair working knowledge of the Cambrian, Ordovician, Silurian, Mississippian, Pennsylvanian, and Permian Periods. It will treat of the physical conditions and life of those periods. It is to be taken in connection with the laboratory study of Paleontology.

Text-book: *Geology, Vol. II, Paleozoic,* Chamberlin and Salisbury.

M. Geol. Sophomore Year, First Semester, 2 hours.

Geol. 8. **Mesozoic and Cenozoic Geology.**

Preparation required: Geol 7.

Taken with G. Lab. 2., Pal. 2., Pal. L. 2.

In this course it is intended to give the student a fair working knowledge of the Triassic, Jurassic, Comanchean, Cretaceous, Eocene, Miocene, Pliocene, Pleistocene, and Neocene Periods. It will treat of the physical conditions and life of those periods. It is to be taken in connection with further laboratory study of Palaeontology.

Text-book: *Geology, Vol. III, Mesozoic and Cenozoic,* Chamberlin and Salisbury.

M. Geol. Sophomore Year, Second Semester, 2 hours.

Geol. 9. **Glacial Geology.**

Preparation required: Geol. 8.

This course will relate to the general phenomena of ancient and modern glaciation, with particular attention given to North America.

Text-books: *The Ice Age in North America,* Wright; *The Great Ice Age,* Geikie.

Elect. Junior Year, First Semester, 2 hours.

Geol. 10. **Pehistoric Man.**

Preparation required: Geol 9.

This course specially treats of the various evidences of the presence of man in the Pleistocene and Neocene Periods, as well as the questions relating to his earlier appearance. Attention is further given to the correlated geology.

Text-book: *Prehistoric Europe,* Geikie, etc.

Elect. Junior Year, Second Semester, 2 hours.

Geol. 11. **Geology of the United States.**

Preparation required: Geol. 6, 7, 8, Min. L. 7.

In this course particular attention is given to the Palaeontology and Stratigraphical Geology of the United States.

Text-book: *Manual of Geology*, Dana, and *the Reports of the United States and State Geological Surveys.*

Elect. Senior Year, First Semester, 2 hours.

Geol. 12. **Geology of Pennsylvania.**

Preparation required: Geol. 11.

Attention is given in this course to the topography of the State, its various geological formations, their distribution and relations, and to their economic deposits and fossils.

Text-books: The Reports of the First and Second Geological Surveys of Pennsylvania, etc.

Elect. Senior Year, Second Semester, 2 hours.

Geol. 13. **Volcanoes and Earthquakes.**

Preparation required: Geol. 6., Pet. L. 1., Pet. 1.

Taken with Pet. L. 2., Pet. 2.

This course will treat of volcanic and earthquake phenomena, and such other phenomena as appear to be dependent upon the earth's heated interior. It is especially intended as an aid in the study of the rocks, metamorphic phenomena, and ore deposits.

Text-books: *Volcanoes,* Bonney; *Volcanoes,* Judd; *Volcanoes, Past and Present,* Hull; *Earthquakes,* Milne; *Earthquakes,* Dutton.

Elect. Junior Year, Second Semester, 2 hours.

Geol. 14. **Azoic or Archaean Geology.**

Preparation required Geol. 6, Pet. 3, Pet. L. 3. Geol. 13 is recommended, but not required.

Taken with Pet. 4, Pet. L. 4.

In this course is taken up the history of the discussions relating to the Azoic or Archaean system, and the development of the views relating thereto. It will describe the rocks, their mode of formation, and the various subdivisions of the system and the evidences upon which they are based.

The instruction will be given by lectures and by the study of reports.

E. Geol., M. Geol. Senior Year, Second Semester, 2 hours.

Geol. 15. **History of Geology and Palaeontology.**
Preparation required: Geol. 6, 7, 8, 13, 14; Pet. 1, 2, 3, 4; Pet. L. 1, 2. 3. 4.

In this course will be traced the evolution of opinions in Geology, Petrography, and Palaeontology in order that the student may obtain a clear understanding of the development of these sciences.

Text-books: *History of Geology and Paleontology*, Zittel; *Founders of Geology*, Geikie.

Graduate Work, First Semester, 2 hours.

Geol. 16. **The Philosophy of Geology.**
Preparation required: Geol. 6, 7, 8, 13, 14; Pet. 1, 2, 3, 4; Pet. L. 1, 2, 3, 4.
Taken with Geol. 15.

Graduate Work, First Semester, 2 hours.

Geol. 17. **The Philosophy of Geology, Continued.**
Preparation required: Geol. 16.

Graduate Work, Second Semester, 2 hours.

Courses 16 and 17 in Geology will take up the modes of thought employed in modern geological reasoning and discuss the soundness of the principles involved. The discussion will be based largely upon matter contained within the following:

Text-books: *The Face of the Earth*, Suess; *Principles of Geology*, Lyell.

Geol. 18. **Physical and Chemical Geology.**
Preparation required: Geol. 6, 13, 14; Pet. 1, 2, 3, 4; Pet. L. 1, 2, 3, 4.

Graduate Work, First Semester, 2 hours.

Geol. 19. **Physical and Chemical Geology.**
Preparation required: Geol. 18.

Graduate Work, Second Semester, 2 hours.

Courses 18 and 19 in Geology will treat of the structure of the earth's interior, the principles and evidences relating thereto, the applications of physical and chemical principles to the earth's development, and to its modifications.

The discussion will be largely based upon the following text-books: *Physical Geology*, Green; *Controverted Questions in Geology*, Prestwich; *Geology*, Prestwich; *Phillips Manual of Geology*, Seeley; *Physics of the Earth's Crust*, Fisher; *The Evolution of Earth Structure*, Reade, etc.

GEOLOGICAL LABORATORY.

The courses in the Geological Laboratory are intended to supplement the work in Geology and Mining. It is purposed to train the student in the practical methods of observation in the field and in making his own maps and sections in the laboratory. The work is so arranged that the student can take one or more of the courses as he wishes. Excursions will be taken for the purpose of field study. The text-books used are the *Outlines of Field Geology,* Geikie; and *Structural and Field Geology,* Geikie.

G. Lab. 1. **Field Geology and Geological Surveying and Mapping.**
Taken with Geol. 6.
Sh. Min., M. Geol.
Freshman and Sophomore Years, First Semester, 6 hours.

G. Lab. 2. **Field Geology and Geological Surveying and Mapping.**
Preparation required: Geol. 6.
Mine., M. Geol. Sophomore Year, Second Semester, 6 hours.

G. Lab. 3. **Field Geology and Geological Surveying and Mapping.**
Taken with G. Lab. 1.
Elect. Freshman and Sophomore Years, First Semester, 2 to 12 hours.

G. Lab. 4. **Field Geology and Geological Surveying and Mapping.**
Taken with G. Lab. 2.
Elect. Freshmen and Sophomore Years, Second Semester, 2 to 12 hours.

G. Lab. 5. **Field Geology and Geological Surveying and Mapping.**
Preparation required: G. Lab. 1 or 2.
Elect. Sophomore and Junior Years, First Semester, 4 to 12 hours.

G. Lab. 6. **Field Geology and Geological Surveying and Mapping.**
Preparation required: G. Lab. 1 or 2.
Elect. Sophomore and Junior Years, Second Semester, 4 to 12 hours.

G. Lab. 7. **Field Geology and Geological Surveying and Mapping.**
Preparation required: G. Lab. 5 or 6.
Elect. Senior Year, First Semester, 4 to 12 hours.

G. Lab. 8. **Field Geology and Geological Surveying and Mapping.**
Preparation required: G. Lab. 5 or 6.
Elect. Senior Year, Second Semester, 4 to 12 hours.

G. Lab. 9. **Geological Field Work.**
Preparation required: Geol. 6, G. Lab. 1 or 2.
Elect. Sophomore Summer School, 100 hours.

G. Lab. 10. **Geological Field Work.**
Preparation required: Geol. 6, G. Lab. 9.
Elect. Junior Summer School, 100 hours.

G. Lab. 11. **Geological Field Work.**
Preparation required: Geol. 6, G. Lab. 1 or 2.
Elect. Senior Summer School, 100 hours.

In courses 9, 10 and 11 it is intended to spend the Summer School in the study of the surface and underground geology in one or more mining districts, not only to familiarize the student with geological surveying and mapping, but also to point out to him the relations of geological work to mining.

G. Lab. 12. **Practical Work in Geology.**
Prepartion required: Geol. 6, G. Lab. 1 or 2.
Elect. Sophomore Year, Summer Vacation, 10 weeks.

G. Lab. 13. **Practical Work in Geology.**
Preparation required: Geol. 6, G. Lab. 1 or 2.
Elect. Junior Year, Summer Vacation, 10 weeks.

G. Lab. 14. **Practical Work in Geology.**
Preparation required: Geol. 6, G. Lab. 1 or 2.
Elect. Senior Year, Summer Vacation, 10 weeks.

G. Lab. 15. **Practical Work in Geology.**
Preparation required: Geol. 16, 17, or 18, 19, G. Lab. 1 or 2.
Elect. Graduate Work, Summer Vacation, 10 weeks.

METALLURGY.

Instruction in Metallurgy begins with the first semester of the Junior Year. There is first given a course which covers the general principles of Metallurgy, fuels, furnaces, fluxes, slags, and a short survey of the whole field. This is followed with a number of courses, which deal in detail with the different phases of the subject.

It is the purpose of the instruction in Metallurgy to give a thorough understanding of the principles which govern the different metallurgical processes, together with the study of the best and latest methods and apparatus for carrying them out, so that one may take up actual work in Metallurgy in an intelligent manner and combine theoretical with practical knowledge.

The library contains a very complete collection of metallurgical works, and files of the leading periodicals dealing with Mining and Metallurgy are available for reference and study.

The instruction is aided by collections of fuels, slags, fluxes, alloys, metals, and various furnace products, together with samples of various kinds of iron and steel and their finished products, models of furnaces, blue prints, and lantern slides.

The Metallurgical Laboratory work also supplements the class room instruction and furnishes apparatus for illustration and study. Occasional metallurgical inspection trips also serve to give an idea of the practical operation of the processes studied in class room and laboratory. For these trips, the iron works at Bellefonte, the works of the Cambria Steel Company, at Johnstown, and other plants are easily accessible.

Met. 1. **Metallurgy of Engineering Materials.**
Preparation required Ch. 1, 2, 3.

This course covers very briefly the principles of Metallurgy, refractory materials, and the manufacture and properties of cast iron, wrought iron, and the various kinds of steel.

Text-book: *Johnston's Materials of Construction*, with additional notes.

C. E., M. E., E. E., I. Ch., Math.
Junior Year, Second Semester, 2-0 hours.

Met. 2. **Principles of Metallurgy.**

Preparation required: Ch. 1, 2, 3.

This course covers the field of fuels, furnaces, refractory materials, principles of metallurgy, and the metallurgy of iron and steel.

Text-book: *Rhead's Metallurgy.* Lectures and notes are also given.

Ch., I. Ch. Senior Year, First Semester, 3 hours.

Met. 3. **Metallurgy of Copper, Silver, Gold, Lead, Zinc, and other Metals.**

Preparation required: Met 2.

The work in this course consists of lectures and text book instruction in the Metallurgy of the more important non-ferrous metals, such as copper, lead, zinc, tin, gold, silver, nickel, and others.

Text-book: *Text-Book of Metallurgy*, Schnabel-Louis.

Ch., I. Ch. Senior Year, Second Semester, 4 hours.

Met. 4. **The Principles of Metallurgy.**

Preparation required: Ch. 1, 2.

This is an elementary course giving the principles which underlie the general subject of Metallurgy—it deals briefly with fuels, fluxes, slags, furnaces, refractory materials, metallurgical processes, and aims to cover the entire field in preparation for the more detailed courses which are given later.

Text-Book: *Rhead's Metallurgy*, and notes.

E. M., Mine., E. Geol., M. Geol., E. Met., Met. Junior Year, First Semester, 3 hours.

Met. 5. **Fuels, Furnaces, Calorimetry, Pyrometry, etc.**

Preparation required: Met. 4.

Attention is paid to the preparation, properties, uses and valuation of fuels, and the different forms of calorimeters, and the methods of determining the heating values of fuels are carefully studied. The measurement of high temperatures upon which the successful application of metallurgical principles rests is treated very fully.

Select. Junior Year, Second Semester, 3 hours.

Met. 6. **Refractory Materials.**

Preparation required: Met. 4.

The manufacture, properties, uses and testing of the various materials employed for furnace linings, crucibles, and in other metallurgical operations, to withstand the action of heat and slags, such as fire clays, fire brick, gannister, chromite, magnesite, silica and others.

Select. Junior Year, Second Semester, 1 hour.

Met. 7. **Gas Producers.**

Preparation required: Met. 4.

The methods of making gases for metallurgical and other uses, together with a study of the types of producers used and the methods of testing producers.

Select. Senior Year, First Semester, 2 hours.

Met. 8. **Metallography. The Microscopic Study of Metals and Alloys.**

Preparation required: Met. 4., Met. L. 1.
Taken with Met. L. 6.

Deals with the theories of heat treatment of metals and alloys, and with the methods of making the structure visible. It also considers the influences of changes of structure in the properties of the metals or alloys.

Select. Senior Year, First Semester, 1 hour.

Met. 9. **Blast Furnaces, Foundry Work, Cast Iron, etc.**

Preparation required: Met. 4.

This course deals in detail with all the phases of furnace practice and foundry work. Some of the topics considered are as follows: The blast furnace, the blast furnace plant, the furnace burden, ore mixing, the calculation of furnace burdens, the operation of the blast furnace, the chemistry of the production of pig iron, the use of the dry air blast, the properties of pig iron, the grading of pig iron, the testing of pig iron, the foundry, methods of remelting, cupolas, charging cupolas, air furnaces, crucibles, making castings, properties of cast iron, effects of methods of remelting on the composition and properties of cast iron, testing cast iron for foundry uses, malleable cast iron, wrought iron, etc.

Select. Senior Year, First Semester, 3 hours.

Met. 10. **Steel.**

Preparation required: Met. 9.

Deals with the methods of manufacture, the different varieties, the mechanical and heat treatment of steels, the relations between composition and properties and the methods of production.

Select. Senior Year, Second Semester, 4 hours.

Met. 11. **Copper.**

Preparation required: Met. 4.

The production and properties of copper, including roasting of the ores, the blast furnace matting processes, the reverberatory matting processes, pyritic smelting, Bessemerizing mattes, reverberatory processes for obtaining copper, the refining of coppers, electrolytic refining, etc.

Select. Senior Year, First Semester, 2 hours.

Met. 12. **Lead.**

Preparation required: Met. 4.

This course covers the preparation and properties of lead, including the roasting of the ores, the blast furnace processes, the hearth processes, the reverberatory processes, the methods of extracting silver and gold, and the refining of lead.

Select. Senior Year, First Semester, 2 hours.

Met. 13. **Gold and Silver.**

Preparation required: Met. 4, Ore 1, or Ore 2.

Deals with the various methods of extracting gold and silver from their ores.

Select. Senior Year, Second Semester, 2 hours.

Met. 14. **The Metallurgy of the Minor Metals.**

Preparation required: Met. 4.

Deals with the production and properties of the less important metals, such as zinc, tin, antimony, nickel, chromium, manganese, etc.

Select. Senior Year, Second Semester, 2 hours.

Met. 15. **Alloys.**

Preparation required: Met. 4.

This course treats of the manufacture, properties and uses of alloys, such as brasses, bronzes, fusible metals, solders, friction metals, etc.

Select. Junior Year, Second Semester, 1 hour.

Met. 16. **Electro Metallurgical Processes.**
Preparation required: Met. 4.

Deals with those metallurgical processes in which electricity plays a part, such as the electric furnace methods of producing iron and steel, aluminum, ferro alloys, electrolytic methods of refining of copper, lead, gold and silver.

Select. Junior Year, Second Semester, 3 hours.

METALLURGICAL LABORATORY.

There are a number of lines of laboratory work indicated, which serve to give practical knowledge concerning the Metallurgical laws and processes studied in the class room.

The laboratory is rapidly accumulating a stock of apparatus for this work. Some of the lines which can be followed are as follows: Assaying, Fuel Testing, Refractory Materials, General Metallurgical Experiments, Experiments with Iron and Steel, Metallurgical Calculations, and Metallurgical Designing.

There is an excellent equipment of furnaces for assaying and metallurgical work, a number of assay balances, an Atwater bomb calorimeter for testing the heating values of coals, pyrometers for the measurement and control of high temperatures, and other apparatus needed for carrying on all kinds of experimental work.

The following courses are given:

Met. L. 1. **General Metallurgical Experimentation.**
Preparation required: Ch. 1, 2, 3, 5, 6. Min. L. 7.
Taken with Met. 4.

A general course in laboratory work covering experiments in fuel testing, calorimeter work, standardization of pyrometers, experiments with reduction and oxidation, some metallography, the making of alloys, the testing of fire clays, annealing and tempering of steels, and other experimental work.

E. Met., Met. Junior Year, First Semester, 4 hours.

Met. L. 2. **General Metallurgical Experimentation.**

Preparation required: Ch. 1, 2., Met. 4, Min. L. 7.

This course follows the same general lines as Met. L. 1.

E. M., Minc., E. Geol., M. Geol.

Junior Year, Second Semester, 4 hours.

Met. L. 3. **General Metallurgical Experimentation.**

Preparation required: Met. L. 1.

A continuation of Met. Lab. 1.

Select. Junior Year, Second Semester, 4 hours.

Met. L. 4. **Fuels and Fuel Testing.**

Preparation required: Met. 4.

Taken with Met. 5.

The analysis of coals, calorimetry, coking properties, washing tests, and physical tests.

Select. Junior Year, Second Semester, 4 hours.

Met. L. 5. **Refractory Materials.**

Preparation required: Met. 4, Met. L. 1 or 2.

Taken with Met. 6.

The manufacture and testing of refractory materials.

Select. Junior Year, Second Semester, 4 hours.

Met. L. 6. **Metallography.**

Preparation required: Met. 4, Met. L. 1 or 2.

Taken with Met. 8.

Includes the methods of polishing, etching, microscopic study, microphotography, study of cooling curves, and the effects of heat and mechanical treatment on metals and alloys.

Select. Senior Year, First Semester, 4 hours.

Met. L. 7. **Experiments with Iron and Steel.**

Preparation required: Met. 4., Met. L. 1. Ch. 5, 6.

Taken with Met. 9.

This course includes work of the following types:

1. Experiments with hardening, tempering, and annealing of steels;
2. Effects of remelting cast irons;
3. Experiments with special steels;
4. The making and testing of test bars;
5. Keep's tests for foundry iron, etc.

Select. Senior Year, First Semester, 4 hours.

Met. L. 8. **Experiments with Iron and Steel.**
Preparation required: Met. L. 7.
Taken with Met. 10.
A continuation of Met. L. 7.
Select. Senior Year, Second Semester, 4 hours.

Met. L. 9. **Experiments in Smelting and Refining.**
Preparation required: Met. 4, Met. L. 17, Ch. 5, 6.
Taken with Met. 11 or 12.
Select. Senior Year, First Semester, 4 hours.

Met. L. 10. **Experiments in Smelting and Refining.**
Preparation required: Met. L. 9.
Taken with Met. 13 or 14.
Select. Senior Year, First Semester, 4 hours.

Met. L. 11. **Experiments in Electro-Metallurgy.**
Preparation required: Met. 4, Met. L. 1, 17, 20.
Taken with Met. 16.
Select. Junior Year, Second Semester, 4 hours.

Met. L. 12. **Research Work in Metallurgy or Assaying.**
Preparation required: Met. 4, Met. L. 1, and other Metallurgical Laboratory work amounting to at least 8 hours.
Elect. Senior Year, First Semester, 4 to 12 hours.

Met. L. 13. **Research Work in Metallurgy or Assaying.**
Preparation required: Same as for Met. L. 12.
Elect. Senior Year, Second Semester, 4 to 12 hours.

Met. L. 14. **Metallurgical Designing.**
Preparation required: Dr. 2., Met. 4., Met. L. 1 or 2.

This course covers the designing of furnaces, smelting plants, ore dressing machinery, ore dressing plants, and other metallurgical or ore dressing apparatus.

E. Met., Met. Senior Year, First Semester, 4 hours.

Met. L. 15. **Metallurgical Designing.**
Preparation required: Met. L. 14.
Continuation of Met. L. 14.
Elect. Senior Year, Second Semester, 4 hours.

Met. L. 16. **Metallurgical Calculations.**

Preparation required: Met. 4, Met. L. 1.

This course deals with the solution of such problems as the Metallurgist may be called upon to solve, and involves the application of chemical and metallurgical knowledge.

Text-book: *Richards' Metallurgical Calculations.*

E. Met., Met. Senior Year, First Semester, 3 hours.

Met. L. 17. **Fire Assaying.**

Preparation required: Ch. 1. 2, Min. L. 7.

This work covers the fire assay of lead, copper, gold and silver ores. The course consists of six hours per week of practical work in the assay laboratory, with occasional lectures and recitations on the theory and methods of fire assaying.

The aim of the course is to afford a thorough training in the theory and practice of assaying lead, copper, gold and silver ores, according to the methods used in practical assay offices, and to so train the student that he may be able to take up and carry on this class of work after graduation.

E. M., Mine., E. Geol., M. Geol., E. Met., Met.
Junior Year, First Semester, 6 hours.

Met. L. 18. **Fire Assaying.**

Preparation required: Ch. 5, 6.

A shorter course, covering about the same ground as Met. L. 17.

Chem., I. Chem. Senior Year, First Semester, 4 hours.

Met. L. 19. **Fire Assaying.**

Preparation required: Met. L. 17.

A continuation of Met. L. 17.

E. Met., Met. Junior Year, Second Semester, 6 hours.

Met. L. 20. **Assaying of Ores, Slags, Fluxes, and Metallurgical Products.**

Preparation required: Ch. 5, 6, Min. L. 7, Met. 4.

E. Met., Met. Junior Year, First Semester, 6 hours.

Met. L. 21. **Assaying of Ores, Slags, Fluxes, and Metallurgical Products, Continued.**

Preparation required: Met. L. 20.

E. Met., Met. Junior Year, Second Semester, 6 hours.

Met. L. 22. **Assaying of Ores, Slags, Fluxes, and Metallurgical Products, Continued.**
Preparation required: Met. L. 21.
Elect. Senior Year, First Semester, 6 hours.

Met. L. 23. **Assaying of Ores, Slags, Fluxes, and Metallurgical Products, Continued.**
Preparation required: Met. L. 22.
Elect. Senior Year, Second Semester, 6 hours.

Met. L. 24. **Practical Work in Metallurgy.**
Preparation required: Met. 2, Met. L. 1 or 2.
Elect. Junior Year, Summer Vacation, 10 weeks.

Met. L. 25. **Practical Work in Metallurgy.**
Preparation required: Completion of the required work in the courses in Metallurgy.
Elect. Senior Year, Summer Vacation, 10 weeks.

Met. L. 26. **Practical Work in Assaying.**
Preparation required: Met. L. 17.
Elect. Junior Year, Summer Vacation, 10 weeks.

Met. L. 27. **Practical Work in Assaying.**
Preparation required: Completion of the required work in the courses in Metallurgy.
Elect. Senior Year, Summer Vacation, 10 weeks.

Met. L. 28. **Metallurgical Inspection Trip.**
Preparation required: Met. 4 and 5 or 6, or 15 or 16.

A metallurgical inspection trip will be arranged for each year, to be taken either during the summer school period, or at Easter Vacation. If taken at Easter Vacation it will be necessary for the trip to be taken two different years in order to obtain full credit for the Junior Summer School.

The plants visited will be those devoted to the preparation and reduction of ores, coal washing, coking, iron and steel working, smelting and refining, and such other work which may be considered to be of interest.

Elect. Junior Year, Summer School, 100 hours.

Met. L. 29. **Research Work in Metallurgy.**
Preparation required: Met. L. 12 or 13.
Elect. Graduate Work, First Semester, 4 to 12 hours.

Met. L. 30. **Research Work in Metallurgy.**
Preparation required: Met. L. 29.
Elect. Graduate Work, Second Semester, 4 to 12 hours.

Met. L. 31. **Research Work in Assaying.**
Preparation required: Met. L. 19, 23.
Elect. Graduate Work, First Semester, 4 to 12 hours.

Met. L. 32. **Research Work in Assaying.**
Preparation required: Met. L. 31.
Elect. Graduate Work, Second Semester, 4 to 12 hours.

Met. L. 33. **Practical Work in Metallurgy.**
Preparation required: Met. L. 30.
Elect. Graduate Work, Summer Vacation, 10 weeks.

Met. L. 34. **Practical Work in Assaying.**
Preparation required: Met. L. 32.
Elect. Graduate Work, Summer Vacation, 10 weeks.

MINERALOGY.

In these courses it is intended to take up the general principles of Crystallography, Mineralogy and Macroscopical Petrography. All, however, have to be taken with the corresponding laboratory work.

Min. 1. **Crystallography and Mineralogy.**
Taken with Min. L. 5.

Text-books: *Crystallography*, Wadsworth; Text-book of *Mineralogy*, Dana; *Practical Mineralogy*, Wadsworth.

Sh. Min., E. M., Mine., E. Geol., M. Geol., E. Met., Met.
Freshman Year, First Semester, 2 hours.

Min. 2. **Mineralogy and Petrography.**
Preparation required: Min. 1, Min. L. 6.
Taken with Min. L. 7.

Text-books: *Text-book of Mineralogy*, Dana; *Practical Mineralogy*, Wadsworth.

Sh. Min., E. M., Mine, E. Geol., M. Geol., E. Met., Met.

Freshman Year, Second Semester, 1 hour, or Sophomore Year, First Semester 1 hour.

Min. 3. **Mathematical Crystallography.**
Preparation required: Mat. 1, 2., Min. 1, 2., Min. L. 7.
Taken with Min. L. 14, Pet. 1, Pet. L. 1.
Elect. Junior Year, First Semester, 2 hours.

Min. 4. **Mathematical Crystallography.**
Preparation required: Min. 3, Min. L. 14.
Taken with Min. L. 15, Pet. 2, Pet. L. 2.
Elect. Junior Year, Second Semester, 2 hours.

In Min. 3 and 4 is taken up the applications of Mathematics in calculating the axial ratios, and the other constants in crystals, also the methods of projecting and drawing crystals. It is thus proposed in these to give a full and complete course in Mathematical Crystallography and crystal projection. The associated practice is to be taken in the Crystallographic Laboratory.

Text-books: *Lectures and Treatise on Crystallography,* Lewis; *Crystallography,* Story-Maskelyne; *Text-book of Mineralogy,* Dana.

Min. 5. **Physical and Chemical Mineralogy.**
Preparation required: Min. 4, Min. L. 15.
Taken with Min. L. 16, Pet. 3, Pet. L. 3.
Elect. Senior Year, First Semester, 2 hours.

Min. 6. **Physical and Chemical Mineralogy.**
Preparation required: Min. 5, Min. L. 16.
Taken with Min. L. 17, Pet. 4, Pet. L. 4.
Elect. Senior Year, Second Semester, 2 hours.

Min. 7. **Physical and Chemical Mineralogy.**
Preparation required: Min. 6, Min. L. 17.
Taken with Min. L. 18.
Graduate Work, First Semester, 2 hours.

Min. 8. **Physical and Chemical Mineralogy.**
Preparation required: Min. 7., Min. L. 18.
Taken with Min. L. 19.
Graduate Work, Second Semester, 2 hours.

Courses Min. 5 to 8 are arranged for the purpose of imparting to the student a full knowledge of the various physical properties of Minerals including their optical characteristics and in part their chemical changes or alterations.

Min. 9. **Mineralogy of United States.**
Preparation required: Min. 6.
Taken with Min. 7.
Graduate Work, First Semester, 2 hours.

Min. 10. **Mineralogy of Pennsylvania.**
Preparation required: Min. 9.
Taken with Min. 8.
Graduate Work, Second Semester, 2 hours.

MINERALOGICAL LABORATORY.

THE instruction in the Mineralogical Laboratory is divided into four parts: Crystallography, Determinative Mineralogy, Physical and Chemical Mineralogy, and Macroscopical Petrography. These are all taken as consecutive and closely co-ordinated subjects that are essential to a proper comprehension of the subjects of Geology and Mining.

Crystallography.—The instruction given is by means of lectures, notes, and laboratory practice in determining the crystal forms of models and natural crystals.

As the student's future work in Mineralogy depends largely upon his knowledge of Crystallography, he is required to familiarize himself with the principles which it involves, and to become sufficiently expert in determining forms to be able to apply it practically in the Determinative Mineralogy.

This work is supplemented in the Junior Year by Mathematical Crystallography, with the use of the goniometer and practice in the drawing of crystals.

Determinative Mineralogy.—For Determinative Mineralogy there is provided a typical set of important minerals, special attention being paid to those of economic value, as well as to those occurring as gangue, or rock-forming minerals. Special collections are arranged, showing the physical characters of minerals.

Besides the typical lecture collections of minerals, there are placed in other drawers specimens of the same mineral species. They are arranged in convenient groups, but are unlabeled. These specimens are selected so as to represent as great a variety of form, appearance, and locality as possible, in order that the student may be made familiar with all the types that he will be likely to meet in his professional practice. Drawers containing these unlabeled minerals are assigned to each student, who is to determine them and recite upon them, not in a class, but singly with the instructor. He is required to do that which the practical mineralogist does: to determine his minerals by the shortest method possible, consistent with accuracy; the method to vary according to the specimen. To this end every method of determination short of quantitative analysis is employed; that is, in each case the crystal form and other physical characters are used, as well as the blowpipe and wet tests, so far as they may be needed.

After the student has studied and recited upon the specimens contained in a sufficient number of drawers of one group, he is assigned drawers containing the unlabeled minerals of another group, which have mixed with them specimens of the preceding group or groups. In this way each student is required to determine in his course from one thousand to three thousand different mineral specimens belonging to the selected species.

As a basis for the Determinative Mineralogy, Dr. Edward S. Dana's Text-book of Mineralogy is used, supplemented by Practical Mineralogy, Wadsworth. In the latter the characteristic features of each mineral, its uses, and the practical methods employed to distinguish each one are pointed out. Especial attention is given to the methods needed in the field and mine, where one cannot have recourse to a chemical laboratory. Every effort is made to train the student to close, accurate observation, to reason correctly upon what he sees, and to exercise good judgment in his decision.

The result of this work is such that a student not only knows how to proceed in order to determine any mineral that he may meet, but he is also enabled to recognize at sight, or by simple tests, the great majority of specimens belonging to the important mineral species selected.

In order to provide for the needs of students in other courses, as well as for those in Mines and Metallurgy, the instruction is divided into two parts:

First, a shorter course covering one hundred and seven mineral species, important from a geological and educational point of view. This work, with the Crystallography, is expected to be taken by all the students of Mineralogy.

Second, a course covering not only the one hundred and seven mineral species, but nearly all other species of economic or geologic importance. This course, in addition to the first, is taken by all students belonging to the School of Mines and Metallurgy.

Physical and Chemical Mineralogy.—In these courses are taken up the general physical properties of minerals, with the use of the polariscope, etc., with the study of their chemical constitution and their alterations.

Macroscopical Petrography.—In this subject the student is taught to determine by means of the eye, the lens, and a few simple tests, how to recognize the principal rocks of the globe. For this work collections of rock specimens are arranged for the use of the student. The course of instruction is similar to that followed in the course of Mineralogy. Lectures are given upon the specimens of the typical collections, the method of classification is explained, and the distinguishing characters of the different groups, species, and varieties are pointed out. Special attention is called to the variations and alterations in rocks and to their local modifications due to their special mode of occurrence in the field.

The object of the course is to give the student such training in the practical determination of rocks as will enable him to know them in the field and mine, as well as to observe their alterations and modifications,—subjects that have a very important bearing upon the vital questions relating to ore deposits.

After the study of a sufficiently large number of types has been made, the student has assigned to him a large number of drawers, containing unlabeled specimens of these rocks, which he is expected to determine and recite upon, as he has done in his study of minerals. The course is thus made thorough and practical, and is adapted to the needs of the miner, the teacher, and the geologist, giving them a training which they can make use of in their future work.

Min. L. 1. **Crystallography and Mineralogy.**
Preparation required: Ch. 1, 2.
G. Sci., Class., L. Sci., Chem. Sophomore and Junior Years, First Semester, 2 hours.

Min. L. 2. **Crystallography and Mineralogy.**
Preparation required: Ch. 1, 2.
Lang., Phil., C. E. Sophomore and Junior Years, First Semester, 4 hours.

Min. L. 3. **Mineralogy and Petrography.**
Preparation required: Min. L. 1.
G. Sci., Class., L. Sci., Chem., Ech. E. Sophomore and Junior Years, Second Semester, 2 or 4 hours.

Min. L. 4. **Mineralogy and Petrography.**
Preparation required: Min. L. 3.
G. Sci., Class., L. Sci., Senior Year, First Semester, 4 hours.

Min. L. 5. **Crystallography and Mineralogy.**
Taken with Min. 1.
Sh. Min., E. M., Mine., E. Geol., M. Geol., E. Met., Met. Freshman Year, First Semester, 7 hours.

Min. L. 6. **Mineralogy and Petrography.**
Preparation required: Min. L. 5.
Taken with Ch. 1, 2.
Sh. Min., E. M., Mine., E. Geol., M. Geol., E. Met., Met. Freshman Year, Second Semester, 10-6 hours.

Min. L. 7. **Mineralogy and Petrography.**
Preparation required: Min. L. 6, Min. 1.
Taken with Min. 2.
Sh. Min., E. M., Mine., E. Geol., M. Geol., E. Met., Met. Freshman Year, Second Semester, or Sophomore Year, First Semester, 10 hours.

Min. L. 8. **Mineralogy and Petrography.**
Preparation required: Min. L. 6.
Taken with Min. L. 7.
Elect. Sophomore Year, First Semester, 2 to 12 hours.

Min. L. 9. **Mineralogy and Petrography.**
Preparation required: Min. L. 7.
Elect. Sophomore Year, Second Semester, 2 to 12 hours.

Min. L. 10. **Mineralogy and Petrography.**
Preparation required: Min. L. 7.
Elect. Junior Year, First Semester, 2 to 12 hours.

Min. L. 11. **Mineralogy and Petrography.**
Preparation required: Min. L. 7.
Elect. Junior Year, Second Semester, 2 to 12 hours.

Min. L. 12. **Mineralogy and Petrography.**
Preparation required: Min. L. 7.
Elect. Senior Year, First Semester, 2 to 12 hours.

Min. L. 13. **Mineralogy and Petrography.**
Preparation required: Min. L. 7.
Elect. Senior Year, Second Semester, 2 to 12 hours.

Min. L. 14. **Crystallographic Laboratory.**
Preparation required: Min. 2., Min L. 7.
Taken with Min. 3, Pet. 1, Pet. L. 1.
Elect. Junior Year, First Semester, 4 to 12 hours.

Min. L. 15. **Crystallographic Laboratory.**
Preparation required: Min. L. 14.
Taken with Min. 4, Pet. 2, Pet. L. 2.
Elect. Junior Year, Second Semester, 4 to 12 hours.

Min. L. 16. **Physical and Chemical Mineralogy.**
Preparation required: Min. L. 15.
Taken with Min. 5., Pet. 3., Pet. L. 3.
Elect. Senior Year, First Semester, 4 to 12 hours.

Min. L. 17. **Physical and Chemical Mineralogy.**
Preparation required: Min. L. 16.
Taken with Min. 6, Pet. 4, Pet. L. 4.
Elect. Senior Year, Second Semester, 4 to 12 hours.

Min. L. 18. **Physical and Chemical Mineralogy.**
Preparation required: Min. L. 17.
Taken with Min. 7.
Graduate Work, First Semester, 4 to 12 hours.

Min. L. 19. **Physical and Chemical Mineralogy.**
Preparation required: Min. L. 18.
Taken with Min. 8.
Graduate Work, Second Semester, 4 to 12 hours.

Min. L. 20. **Research Work in Mineralogy.**
Preparation required: Min. L. 17.
Taken with Min. L. 18.
Graduate Work, First Semester, 4 to 12 hours.

Min. L. 21. **Research Work in Mineralogy.**
Preparation required: Min. L. 20.
Taken with Min. L. 19.
Graduate Work, Second Semester, 4 to 12 hours.

Min. L. 22. **Practical Work in Mineralogy.**
Preparation required: Min. L. 7.
Elect. Sophomore Year, Summer Vacation, 10 weeks.

Min. L. 23. **Practical Work in Mineralogy.**
Preparation required: Min. L. 7.
Elect. Junior Year, Summer Vacation, 10 weeks.

Min. L. 24. **Practical Work in Mineralogy.**
Preparation required: Min. L. 7.
Elect. Senior Year, Summer Vacation, 10 weeks.

Min. L. 25. **Practical Work in Mineralogy.**
Preparation required: Min. L. 7.
Elect. Graduate Work, Summer Vacation, 10 weeks.

MINING.

Mine. 1. **The Principles of Mining.**
Preparation required: Min. L. 7, Geol. 6.

This course is intended to give a general resume of the elementary principles of Mining, such as every student of this school should understand. It is also to serve as a basis for the future studies of those students who intend to devote their future life to mining work.

Text-books: *Ore and Stone Mining*, Foster and Brough; *Text-book of Coal Mining*, Hughes.

E. M., Mine., E. Geol., M. Geol., E. Met., Met.
Sophomore Year, Second Semester, 3 hours.

Mine. 2. **Mine Gases, Ventilation, Lighting, Mine Accounts, "Laying Out" of Mines and Underground and Surface Plants.**
Preparation required: Mine. 1, Mat. 1.

In this course especial attention is paid to the details and problems associated with the "laying out" of surface plants and the underground workings of mines; the best methods of ventilating and lighting them; the detection and care of mine gases, and the methods employed in mine accounts. This work is especially intended to cover the usual duties of fire bosses and foremen and to give the knowledge that every superintendent and manager should have. The instruction is given by lectures and text-books.

Text-books: *The Investigation of Mine Air*, Foster; *Ventilation in Mines*, Wabner; *Mine Accounts*, Lawn; etc.

E. M., Mine. Junior Year, First Semester, 3 hours.

Mine. 3. **Mine Calculations and Estimates.**
Preparation required: Mine 1, Mat. 1.

Text-books: *Mine Foreman's Handbook*, Mauchline-Brackett; *Notes and Formulae for Mining Students*, Merivale.

E. M., Mine. Junior Year, Second Semester, 2 hours.

Mine. 4. **Coal Mining.**
Preparation required: Mine. 1.
Taken with Mine 2.
Text-book: *The Colliery Manager's Handbook,* Pamely.
E. M., Mine. Junior Year, First Semester, 2 hours.

Mine. 5. **Coal Mining, Continued.**
Preparation required: Mine. 1, 2, 4.
Taken with Mine 3.
Text-book: *The Colliery Manager's Handbook,* Pamely.
E. M., Mine. Junior Year, Second Semester, 2 hours.

Mine. 6. **Metal Mining.**
Preparation required: Mine. 1, 2, 3, 4, 5.
Taken with M. Lab. 4.
Text-book: *A Manual of Mining,* Ihlseng-Wilson.
E. M., Mine. Senior Year, First Semester, 2 hours.

Mine. 7. **Metal Mining, Continued.**
Preparation required: Mine. 6.
Taken with M. Lab. 5.
Text-book: *A Manual of Mining,* Ihlseng-Wilson.
E. M., Mine. Senior Year, Second Semester, 2 hours.

Mine. 8. **Hydraulic Mining and Dredging.**
Preparation required: Mine. 1.
Taken with Mine. 3.
Text-book: *Practical Treatise on Hydraulic Mining,* Bowie.
E. M., Mine. Junior Year, Second Semester, 2 hours.

Mine. 9. **Mining Engineering.**
Preparation required: Mchs. 2, 3, Hyd. 1, Mine. 1, 2, 3, 4, 5.
Taken with Mine. 6, M. Lab. 4.
Text-book: *Coal and Metal Miner's Pocket-book.*
E. M. Senior Year, First Semester, 3 hours.

Mine. 10. **Mining Engineering.**
Preparation required: Mchs. 3, Mine. 9.
Taken with Mine. 7, 13, M. Lab. 5.
Text-book: *Coal and Metal Miner's Pocket-book.*
E. M. Senior Year, Second Semester, 3 hours.

Courses 9 and 10 deal with those questions which confront the engineer of mines: the utilization of the enormous energy of our manifold streams, now going to waste, by its conversion into electrical power; the proper methods of track location, both inside and outside of the mine; the designing and equipping of mine plants, are here given due consideration.

Mine. 11. **Mine Sampling, Valuation, Economics, Accidents, First Aid to the Injured, etc.**
Preparation required: M. Geol. 1, Mine. 1.

This course includes the methods of sampling ores and obtaining the value of mines; purchase and use of supplies, sale of product; causes of accidents to the mines or to the miners, and their prevention; the clothing, housing and sanitation for the miners; first aid to the injured, etc.

Text-books: *The Sampling and Estimation of Ore in a Mine*, Rickard; *The Economics of Mining*, Rickard; *Accidents and Emergencies*, Dulles; *The Immediate Care of the Injured*, Morrow; etc.

E. M., Mine., E. Geol., M. Geol., E. Met., Met. Senior Year, Second Semester, 3 hours.

Mine. 12. **Mining and Ventilating Machinery.**
Preparation required: Mine. 1, 2, 3, 4, 5.
Taken with Mine. 6.

Text-book: *Machinery for Metalliferous Mines*, Davies.

Mine. Senior Year, First Semester, 2 hours.

Mine. 13. **Power Generation and Transmission in Mines.**
Preparation required: Mine. 1, 2, 3, 4, 5, 6.
Taken with Mine 7.

Text-book: *Power and Power Transmission*, Kerr.

E. M., Mine. Senior Year, Second Semester, 2 hours.

Mine. 14. **Mine Drainage and Pumping.**
Preparation required: Mine. 12.
Taken with Mine. 13.

Mine. Senior Year, Second Semester, 2 hours.

Mine. 15. **Mine Hoisting and Haulage.**
Preparation required: Mine. 1.
Taken with Mine 2, 4.

Text-books: *Mechanics of Hoisting Machinery*, Weisbach and Herrman; *Haulage and Winding Appliances used in Mines*, Volk.

Elect. Junior Year, First Semester, 2 hours.

Mine. 16. **Breaking Ground, (Explosives), Boring, and Shaft Sinking.**
Preparation required: Mine. 1, 2, 4.
Taken with Mine. 3, 5, 8.
Elect. Junior Year, Second Semester, 2 hours.

Mine. 17. **Exploitation and Supporting, including Timbering.**
Preparation required: Mine. 16.
Text-books: *Mine Timbering, Storms*, etc.
Taken with Mine. 6.
Elect. Senior Year, First Semester, 2 hours.

Mine. 18. **Advanced Mining Surveying.**
Preparation required: Sur. 9, 10.
Taken with M. Lab. 15.
Elect. Senior Year, Second Semester, 2 hours.

Mine. 19. **Deep Mining.**
Preparation required: Mine. 9, 10, 12, 13, 14, 15, 16, 17.
Elect. Graduate Work, First Semester, 2 hours.

Mine. 20. **Advanced Mining Engineering.**
Preparation required: Mine. 19.
Elect. Graduate Work, Second Semester, 2 hours.

Mine. 21. **Mine Labor, Management, etc.**
Preparation required: M. Geol. 1, Mine 1, Law 3, 4,
Taken with Mine 11.

This work includes the superintendency and management of labor, strikes, national and state legislation, education, morals, etc.

Text-books: *Labor Problems*, Adams and Sumner; *Anthracite Coal Communities*, Roberts; *The Anthracite Coal Industry*, Roberts; *Colliery Working and Management*, Bulman and Redmayne.

E. M., Mine., E. Geol., M. Geol., E. Met., Met. Senior Year, Second Semester, 3 hours.

MINING LABORATORY.

Instruction in this laboratory directs the attention of the student to the practical questions most likely to be met with in the engineering side of mining. The work is intended to enable the student to design successfully coal tipples, head frames, shaft houses, mill buildings, fans, bents, aerial tramways, chutes, surface arrangements, etc., and to superintend the construction work of the same.

It is intended to give the students practice in testing fans, operating drills, and other mine machinery, detecting mine gases, mine ventilation, experimenting with aerial tramways, endless rope haulage, etc.

M. Lab. 1. **Mining Laboratory and Design.**
Preparation required: Dr. 2, Mat. 1.
Taken with Mine. 1.
Elect. Sophomore Year, Second Semester, 4 to 12 hours.

M. Lab. 2. **Mining Laboratory and Design.**
Preparation required: Dr. 2, Mat. 1, Mine 1.
Taken with Mine. 2 or 4.
Elect. Junior Year, First Semester, 4 to 12 hours.

M. Lab. 3. **Mining Laboratory and Design.**
Preparation required: Dr. 2, Mat. 1, Mine. 1.
Taken with Mine. 3 or 5 or 8.
Elect. Junior Year, Second Semester, 4 to 12 hours.

M. Lab. 4. **Mining Laboratory and Design.**
Preparation required: Dr. 2, Mat. 1, Mine 1, 2, 3, 4, 5.
Taken with Mine. 6.
E. M., Mine. Senior Year, First Semester, 6 hours.

M. Lab. 5. **Mining Laboratory and Design.**
Preparation required: M. Lab. 4.
Taken with Mine. 7.
E. M., Mine. Senior Year, Second Semester, 6 hours.

M. Lab. 6. **Mining Laboratory and Design.**
Taken with M. Lab. 4.
Elect. Senior Year, First Semester, 2 to 12 hours.

M. Lab. 7. **Mining Laboratory and Design.**
Taken with M. Lab. 5.
Elect. Senior Year, Second Semester, 2 to 12 hours.

M. Lab. 8. **Mining and Ventilating Machinery.**
Taken with Mine. 6, 12.
Elect. Senior Year, First Semester, 4 to 12 hours.

M. Lab. 9. **Power Generation and Transmission in Mines.**
Taken with Mine. 7, 13.
Elect. Senior Year, Second Semester, 4 to 12 hours.

M. Lab. 10. **Mine Drainage and Pumping.**
Taken with Mine. 14.
Elect. Senior Year, Second Semester, 4 to 12 hours.

M. Lab. 11. **Mine Hoisting and Haulage.**
Taken with Mine. 15.
Elect. Junior Year, First Semester, 4 to 12 hours.

M. Lab. 12. **Mine Gases, Ventilation, Lighting, etc.**
Taken with Mine 2.
Elect. Junior Year, First Semester, 4 to 12 hours.

M. Lab. 13. **Breaking Ground (Explosives), Boring, and Shaft Sinking.**
Taken with Mine. 16.
Elect. Junior Year, Second Semester, 4 to 12 hours.

M. Lab. 14. **Exploitation and Supporting, including Timbering.**
Taken with Mine. 17.
Elect. Senior Year, First Semester, 4 to 12 hours.

M. Lab. 15. **Advanced Mine Surveying.**
Preparation required: Sur. 9, 10.
Taken with Mine. 18.

This course will continue the previous work in surveying with special field practice in the use of the transit, etc. It will give special instruction in the calculation of notes, the making and the care of maps, both mining and geological, also models and sections. Special and practical problems met in surveying will receive careful attention. The work is designed to prepare the student to survey mines of every kind and their surface locations.

Elect. Senior Year, Second Semester, 4 hours.

M. Lab. 16. **Deep Mining.**
Taken with Mine. 19.
Elect. Graduate Work, First Semester, 4 to 12 hours.

M. Lab. 17. **Advanced Mining Engineering.**
Taken with Mine. 20.
Elect. Graduate Work, Second Semester, 4 to 12 hours.

M. Lab. 18. **Mining Surveying in Mines.**
Preparation required: Sur. 8 or 9.
Elect. Sophomore Year, Summer School, 100 hours.

M. Lab. 19. **Mining and Mining Methods.**
Preparation required: M. Lab. 18, Mine. 1, 2, 3, 4, 5.
Elect. Junior Year, Summer School, 100 hours.

M. Lab. 20. **Mining and Mining Methods.**
Preparation required: M. Lab. 18.
Elect. Senior Year, Summer School, 100 hours.

M. Lab. 21. **Practical Work in Surveying.**
Preparation required: Sur. 2.
Elect. Freshman Year, Summer Vacation, 10 weeks.

M. Lab. 22. **Practical Work in Mining.**
Elect. Freshman Year, Summer Vacation, 10 weeks.

M. Lab. 23. **Practical Work in Mining.**
Preparation required: Mine. 1.
Elect. Sophomore Year, Summer Vacation, 10 weeks.

M. Lab. 24. **Practical Work in Mining.**
Preparation required: Mine. 1, 2, 3, 4, 5.
Elect. Junior Year, Summer Vacation, 10 weeks.

M. Lab. 25. **Practical Work in Mining.**
Preparation required: Mine. 6, 7.
Elect. Senior Year, Summer Vacation, 10 weeks.

M. Lab. 26. **Practical Work in Mining.**
Preparation required: Mine 19, 20.
Elect. Graduate Work, Summer Vacation, 10 weeks.

MINING (Economic) GEOLOGY.

Under this heading will be discussed the geology of the useful or economic mineral products, considered from two different points of view: First, their origin and modes of occurrence; second, their uses. Special attention is given throughout the course to the instruction of the student in Mineralogy, Petrography, and Geology, in order that he may in his future work understand the nature of the deposits upon which he may be employed, since, in the practice of a mining engineer, disastrous mistakes probably occur oftener through ignorance of the petrographical and geological relations of the ore deposits in question than from lack of engineering and metallurgical skill.

Here is discussed the origin, occurrence, and uses of various ores, and the mineral substances used for construction, decoration, fire-resisting, building, pottery, smelting, glass-making, attrition, burning, illustration, lubrication, painting, fertilizing, pyrotechnics, medicines, and in chemistry, etc. In general, it may be said that while it is not intended to neglect any subject properly belonging to Mining Geology, yet, owing to the location of this school, particular attention will be given to the occurrence and use of stone, clay, lime, cement, coal, iron ore and other economic products worked in the State.

M. Geol. 1. **Mining (Economic) Geology.**
Preparation required: Geol. 6, Min. L. 7.
Taken with Mine 1.

Text-books: *Geology Applied to Mining*, Spurr; *Economic Geology of the United States*, Ries; *A Text-book of Mining Geology*, Park.

E. M., Mine., E. Geol., M. Geol., E. Met., Met. Sophomore Year, Second Semester, 3 hours.

M. Geol. 2. **Memetallites or Nonmetalliferous Deposits.**
Preparation required: M. Geol. 1, Geol. 6.

Text-book: *The Non-Metallic Minerals*, Merrill.

Mine., M. Geol. Junior Year, First Semester, 2 hours.

M. Geol. 3. **Metallites or Metalliferous Deposits.**
Preparation required: M. Geol. 1., Geol. 6.

Text-book: *The Nature of Ore Deposits*, Beck-Weed.

E.M., Mine., E. Geol. M. Geol., Junior Year, Second Semester, 3 hours.

M. Geol. 4. **Metallites or Metalliferous Deposits, Continued.**
Preparation required: M. Geol. 3.

Text-books: *The Nature of Ore Deposits*, Beck-Weed; *A Treatise on Ore Deposits*, Phillips-Louis.

Elect. Senior Year, First Semester, 2 hours.

M. Geol. 5. **Ore Deposits of United States.**
Preparation required: M. Geol. 1.
Taken with M. Geol. 3.

Text-book: *The Ore Deposits of the United States and Canada*, Kemp.

Elect. Junior Year, Second Semester, 2 hours.

M. Geol. 6. **Ore Deposits of Europe.**
Preparation required: M. Geol. 5, 22.

Text-books: *A Treatise on Ore Deposits*, Phillips-Louis; *The Nature of Ore Deposits*, Beck-Weed.

Elect. Graduate Work, First Semester, 2 hours.

M. Geol. 7. **Ore Deposits of Asia, Africa, Etc.**
Preparation required: M. Geol. 6, 22.

Text-books: *A Treatise on Ore Deposits*, Phillips-Louis; *The Nature of Ore Deposits*, Beck-Weed; etc.

Graduate Work, Second Semester, 2 hours.

M. Geol. 8. **Mining Geology of Pennsylvania.**
Preparation required: M. Geol. 2, 5, 23.

Text-book: *Reports of the Pennsylvania State Geological Surveys*, etc.

Graduate Work, First Semester, 2 hours.

M. Geol. 9. **Building and Ornamental Stones.**
Preparation required: M. Geol. 1, Geol. 6, Min. L. 7.

Text-book: *Stones for Building and Decoration*, Merrill.

Mine., M. Geol. Junior Year, First Semester, 2 hours.

M. Geol. 10. **Precious Stones or Gems.**
Preparation required: M. Geol. 2, 9.
Taken with Pet. 3, Pet. L. 3.

Text-books: *Precious Stones*, Bauer-Spencer; Cattelle, *Precious Stones*.

Elect. Senior Year, First Semester, 2 hours.

M. Geol. 11. **Clays, Their Occurrence, Properties and Uses.**
Preparation required: M. Geol. 1, 2, Pet. 2., Pet. L. 2.
Taken with Pet. 3, Pet. L. 3.

Text-book: *Clays—Their Occurrence, Properties, and Uses*, Ries.

Elect. Senior Year, First Semester, 2 hours.

M. Geol. 12. **Limes, Mortars, Plasters, Cements, etc.**

Preparation required: M. Geol. 11, Pet. 3, Pet. L. 3.

Taken with Pet. 4, Pet. L. 4.

Text-book: *Cements, Limes, and Plasters*, Eckel.

Elect. Senior Year, Second Semester, 2 hours.

M. Geol. 13. **Coal—Its Origin, Occurrence, Distribution, Properties, and Uses.**

Preparation required: Geol. 6, M. Geol. 1.

Taken with M. Geol. 2, Pet. 1, Pet. L. 1.

Elect. Junior Year, First Semester, 2 hours.

M. Geol. 14. **Petroleum, Natural Gas, Asphaltum, and Other Hydrocarbons.**

Preparation required: Geol. 6, M. Geol. 1, 2, 13.

Elect. Junior Year, Second Semester, 2 hours.

M. Geol. 15. **Road and Refractory Materials, Abrasives, Fluxes, Phosphates, etc.**

Preparation required: Geol. 6, M. Geol. 1, 2, 9, 11, 12, 22; Pet. 4, Pet. L. 4.

Text-books: *Mica and the Mica Industry*, Colles; *Mica—Its Occurrence, Exploitation and Uses*, Cirkel; *Asbestos—Its Occurrence, Exploitation, and Uses*, Cirkel; *Phosphates of America*, Wyatt; etc.

Elect. Graduate Work, Second Semester, 2 hours.

M. Geol. 16. **Waters, Salines, Pigments, Mineral Medicines, and Glass Making.**

Preparation required: M. Geol. 1, 2, 11, 12.

Graduate Work, First Semester, 2 hours.

M. Geol. 17. **Iron Ores.**

Preparation required: M. Geol. 1, 3, 4, Pet. 2, Pet. L. 2.

Taken with Pet. 3, Pet. L. 3.

Elect. Senior Year, First Semester, 2 hours.

M. Geol. 18. **Copper Deposits.**

Preparation required: M. Geol. 1, 3, 4, 5, 17; Pet. 3, Pet. L. 4.

Taken with M. Geol. 22; Pet. 4, Pet. L. 4.

Text-book: *Weed's Copper Mines of the World.*
Elect. Senior Year, Second Semester, 2 hours.

M. Geol. 19. **Gold, Silver, and Silver Lead Deposits.**
Preparation required: M. Geol. 18, 20, 22.
Graduate Work, Second Semester, 2 hours.

M. Geol. 20. **Tin, Lead, Zinc, and Mercury Deposits.**
Preparation required: M. Geol. 3, 18, 22.
Graduate Work, First Semester, 2 hours.

M. Geol. 21. **Aluminum, Chromium, Manganese, Nickel, Platinum, and other Minor Deposits.**
Preparation required: M. Geol. 18, 20.
Taken with Geol. 19.
Graduate Work, Second Semester, 2 hours.

M. Geol. 22. **The Theory of Ore Deposits.**
Preparation required: M. Geol. 1, 3, 5, Pet. 3, Pet. L. 3.
Taken with Pet. 4, Pet. L. 4.
Text-book: *Genesis of Ore Deposits,* Posepny.
Elect. Senior Year, Second Semester, 2 hours.

MINING GEOLOGICAL LABORATORY.

M. G. L. 1. **Mining Geological Laboratory.**
Taken with M. Geol. 1.
Elect. Sophomore Year, Second Semester, 2 to 12 hours.

M. G. L. 2. **Mining Geological Laboratory.**
Taken with M. Geol. 2.
Elect. Junior Year, First Semester, 2 to 12 hours.

M. G. L. 3. **Mining Geological Laboratory.**
Taken with M. Geol. 3.
Elect. Junior Year, Second Semester, 2 to 12 hours.

M. G. L. 4. **Mining Geological Laboratory.**
Taken with M. Geol. 4.
Elect. Senior Year, First Semester, 2 to 12 hours.

M. G. L. 5. **Mining Geological Laboratory.**
Taken with M. Geol. 5.
Elect. Junior Year, Second Semester, 2 to 12 hours.

M. G. L. 6. **Mining Geological Laboratory.**
Taken with M. Geol. 6.
Graduate Work, First Semester, 2 to 12 hours.

M. G. L. 7. **Mining Geological Laboratory.**
Taken with M. Geol. 7.
Elect. Graduate Work, Second Semester, 2 to 12 hours.

M. G. L. 8. **Mining Geological Laboratory.**
Taken with M. Geol. 8.
Elect. Graduate Work, First Semester, 2 to 12 hours.

M. G. L. 9. **Mining Geological Laboratory.**
Taken with M. Geol. 9.
Elect. Junior Year, First Semester, 2 to 12 hours.

M. G. L. 10. **Mining Geological Laboratory.**
Taken with M. Geol. 10.
Elect. Senior Year, First Semester, 2 to 12 hours.

M. G. L. 11. **Mining Geological Laboratory.**
Taken with M. Geol. 11.
Elect. Senior Year, First Semester, 2 to 12 hours.

M. G. L. 12. **Mining Geological Laboratory.**
Taken with M. Geol. 12.
Elect. Senior Year, Second Semester, 2 to 12 hours.

M. G. L. 13. **Mining Geological Laboratory.**
Taken with M. Geol. 13.
Elect. Junior Year, First Semester, 2 to 12 hours.

M. G. L. 14. **Mining Geological Laboratory.**
Taken with M. Geol. 14.
Elect. Junior Year, Second Semester, 2 to 12 hours.

M. G. L. 15. **Mining Geological Laboratory.**
Taken with M. Geol. 15.
Elect. Graduate Work, Second Semester, 2 to 12 hours.

M. G. L. 16. **Mining Geological Laboratory.**
Taken with M. Geol. 16.
Graduate Work, First Semester, 2 to 12 hours.

M. G. L. 17. **Mining Geological Laboratory.**
Taken with M. Geol. 17.
Elect. Senior Year, First Semester, 2 to 12 hours.

M. G. L. 18. **Mining Geological Laboratory.**
Taken with M. Geol. 18.
Senior Year, Second Semester, 2 to 12 hours.

M. G. L. 19. **Mining Geological Laboratory.**
Taken with M. Geol. 19.
Graduate Work, Second Semester, 2 to 12 hours.

M. G. L. 20. **Mining Geological Laboratory.**
Taken with M. Geol. 20.
Graduate Work, First Semester, 2 to 12 hours.

M. G. L. 21. **Mining Geological Laboratory.**
Taken with M. Geol. 21.
Graduate Work, Second Semester, 2 to 12 hours.

M. G. L. 22. **Mining Geological Laboratory.**
Elect. Senior Year, Second Semester, 2 to 12 hours.
Taken with M. Geol. 22.

M. G. L. 23. **Field Work in Mining Geology.**
Preparation required: Min. L. 7, M. Geol. 1, Geol. 6, G. Lab. 1, 2.
Elect. Sophomore Year, Summer School, 100 hours.

M. G. L. 24. **Field Work in Mining Geology.**
Preparation required: M. Geol. 1, 2, 3, 9, 10.
Elect. Junior Year, Summer School, 100 hours.

M. G. L. 25. **Field Work in Mining Geology.**
Preparation required: M. Geol., 1, 2, 3, 9, 10, 11, 12.
Elect. Senior Year, Summer School, 100 hours.

M. G. L. 26. **Practical Work in Mining Geology.**
Preparation required: Min. L. 7, M. Geol. 1, Geol. 6, G. Lab. 1, 2.
Elect. Sophomore Year, Summer Vacation, 10 weeks.

M. G. L. 27. **Practical Work in Mining Geology.**
Preparation required: M. Geol. 1, 2, 3, 9, 10.
Elect. Junior Year, Summer Vacation, 10 weeks.

M. G. L. 28. **Practical Work in Mining Geology.**
Preparation required: M. Geol. 1, 2, 3, 5, 9, 10, 11, 12, 22.
Elect. Senior Year, Summer Vacation, 10 weeks.

M. G. L. 29. **Practical Work in Mining Geology.**
Preparation required: M. Geol. 5, 22.
Elect. Graduate Work, Summer Vacation, 10 weeks.

MINING LAW.

Law. 3. **Principles of Law, and Law of Contracts.**
Preparation required: M. Geol. 1, Mine 1.

Text-books: *The Elements of Law*, Davis; *Elementary Law*, Robinson; *Commercial Correspondence*, Altmair; *The Law of Contracts*, Wait.

E. M., Mine., E. Geol., M. Geol., E. Met., Met. Senior Year, First Semester, 3 hours.

Law. 4. **Mining Law and Law of Mining Injuries.**
Preparation required: M. Geol. 1, Mine. 1.
Taken with or preceded by Law 3.

Text-book: *The Law of Mines and Mining in the United States*, Barringer and Adams; *The Law of Mines and Mining Injuries*, White; *Business Organization*, Sparling.

E. M., Mine., E. Geol., M. Geol., E. Met., Met. Senior Year, First Semester, 3 hours.

Law. 5. **Law Relating to Oil and Gas.**
Taken with or preceded by Law 4.

Text-books: *The Law relating to Oil and Gas*, Thornton; *The Law of Petroleum and Natural Gas*, Donahue.

Elect. Senior Year, First Semester, 2 hours.

Law. 6. **Mining Law, Continued.**
Preparation required: Law 3, 4.

Text-book: *Law of Mines and Mining Rights*, Snyder.

Elect. Senior Year, Second Semester, 3 hours.

Law. 7. **The Law of Negligence and of Personal Injuries in Mines.**
Preparation required: Law 3, 4.

Text-books: *The Law of Negligence*, Barrows; *The Law of Personal Injuries in Mines*, White.

Elect. Senior Year, Second Semester, 3 hours.

Law. 8. **Introduction to American Law and the Law of Contracts, Limitations, and Frauds as applied to Mining.**
Preparation required: Law 3, 4, 5, 6, 7.

Text-books: *An Introduction to American Law*, Walker; *Handbook of the Law of Contracts*, Clark-Tiffany; *The Law of Fraud*, Smith, etc.

Elect. Graduate Work, First Semester, 3 hours.

Law. 9. **The Law of Engineering Operations.**
Preparation required: Law 3, 4, 5, 6, 7, 8.

Text-books: *The Law of Operations Preliminary to Construction in Engineering and Architecture*, Wait; *Engineering and Architectural Jurisprudence*, Wait.

Elect. Graduate Work, Second Semester, 3 hours.

Law 10. **Mining Laws of Great Britain.**

Preparation required: Law 3, 4, 5, 6, 7, 8.

Text-books: *The Law of Mines and Minerals*, Bainbridge and Brown; *The Law of Mines, Quarries and Minerals*, Macswinney and Bristowe; *Mining Law of the British Empire*, Alford.

Elect. Graduate Work, First Semester, 3 hours.

Law 11. **Mining Laws of Mexico and other Foreign Countries.**

Preparation required: Law 3, 4, 5, 6, 7.

Elect. Graduate Work, Second Semester, 2 hours.

ORE DRESSING AND COAL WASHING.

The subject of Ore Dressing is rapidly becoming one of the most important studies for the Mining Engineer and Metallurgist.

Ores as found and brought out from the mine rarely, if ever, consist of pure minerals, but of mixtures of the mineral or minerals wanted, with foreign or worthless material. If these can be removed by mechanical means it is often much more profitable to do so than to attempt to smelt the whole ore.

Many ores which up to a short time ago resisted all attempts at profitable smelting, are now yielding large profits owing to the introduction of dressing methods.

Ore. 1. **Principles of Ore Dressing and Coal Washing.**

Preparation required: Met. 4, Min. L. 7.

This course deals briefly with the machinery used for ore concentration and coal washing, and also takes up the methods of ore dressing and the plants used. In this course are considered the theoretical principles involved in the concentration and preparation for the smelters of gold, silver, lead, copper, iron, zinc, and other ores, as well as the washing of coal, clay, etc., and their preparation for market.

E. M., Mine., E. Geol., M. Geol. Senior Year First Semester, 2 hours.

Ore. 2. **Ore Dressing Operations and Machinery.**

Preparation required: Met. 4., Min. L. 7.

A more extended course than Ore 1, which covers the field of concentration and concentrating machinery and mills.

E. Met., Met. Senior Year, First Semester, 2 hours.

Ore. 3. **Coal Washing and Preparation for Market.**

Preparation required: Met. 4, Min. L. 7.

Covers the machinery for and the methods of preparing anthracite and bituminous coals for market and for coke making.

E. Met., Met. Senior Year, First Semester, 2 hours.

Ore. 4. **Gold and Silver Milling.**

Preparation required: Ore 1, or 2.

This course takes up in detail the methods of obtaining gold and silver from their ores by milling methods.

E. Met., Met. Senior Year, Second Semester, 2 hours.

Ore. 5. **Hydro-Metallurgy.**

Preparation required: Met. 2, Ore. 1, or 2.

This course deals with the methods of extracting gold, silver, copper, lead, zinc, and other metals from their ores by means of solutions, thus including the Cyanide process, the Chlorination process, the Hypo-sulphite process, etc.

E. Met., Met. Senior Year, Second Semester, 2 hours.

ORE DRESSING LABORATORY.

Ore. L. 1. **Ore Dressing Machinery.**

Preparation required: Met. 4, Met. L. 1, or 2, and 17.

Taken with Ore 1, or 2.

This work comprises laboratory experiments with various types of concentrating and dressing machinery, as well as tests of various ores to determine whether they can or can not be successfully concentrated.

Elect. Senior Year, First Semester, 6 hours.

Ore. L. 2. **Coal Washing and Coal Washing Machinery.**

Preparation required: Met. 4, Met. L. 1 or 2.

Taken with Ore 3.

This course includes laboratory experiments in the washing of coals, and the testing of coals to determine what the effects of washing will be.

Elect. Senior Year, First Semester, 6 hours.

Ore. L. 3. **Gold and Silver Milling.**
Preparation required: Met. 4, Met. L. 17 and 1 or 2, Ore 2.
Taken with Ore. 4.

The work here includes a study of the methods of milling gold and silver ores and the testing of such ores by various milling processes.

Elect. Senior Year, Second Semester, 6 hours.

Ore. L. 4. **Hydro-Metallurgy.**
Preparation required: Met 2, Met. L. 17 and 1 or 2, Ore 2.
Taken with Ore 5.

This work includes experiments with wet processes of extracting metals from their ores, and tests to determine the availability of such wet processes for particular ores.

Elect. Senior Year, Second Semester, 6 hours.

Ore. L. 5. **Practical Work in Ore Dressing.**
Preparation required: Ore 1 or 2 .
Elect. Senior Year, Summer Vacation, 10 weeks.

Ore. L. 6. **Practical Work in Coal Washing.**
Preparation required: Ore 1 or 3.
Elect. Senior Year, Summer Vacation, 10 weeks.

Ore. L. 7. **Practical Work in Ore Dressing.**
Preparation required: Ore L. 1.
Graduate Work, Summer Vacation, 10 weeks.

Ore. L. 8. **Practical Work in Coal Washing.**
Preparation required: Ore L. 2.
Elect. Graduate Work, Summer Vacation, 10 weeks.

PALEONTOLOGY.

The object of these courses is to familiarize the student in the field and laboratory with the more common fossils, particularly those that characterize the Paleozoic formations. Naturally, especial attention will be given to the Pennsylvania flora and fauna. The student will be practiced in the determination of various types which he is expected to draw and describe.

The class room work with the associated laboratory work is arranged largely for its use in prospecting and mining in the coal and other stratified formations.

Pal. 1. **Paleontology.**

Taken with Pal. L. 1, Geol. 7.

Text-book: *Text-book of Paleontology*, Zittel-Eastman.

M. Geol. Sophomore Year, First Semester, 1 hour.

Pal. 2. **Paleontology.**

Preparation required: Pal. 1, Geol. 7.

Taken with Pal. L. 2, Geol. 8.

Text-book: *Text-book of Paleontology*, Zittel-Eastman.

M. Geol. Sophomore Year, Second Semester, 1 hour.

Pal. 3. **Paleontology.**

Preparation required: Pal. 2, Pal. L. 2, Geol. 8.

Taken with Pal. L. 3.

Text-books: *Text-book of Paleontology*, Zittel-Eastman; *Vertebrate Paleontology*, Woodward.

Elect. Junior Year, First Semester, 2 hours.

Pal. 4. **Paleontology.**

Preparation required: Pal. 3., Pal. L. 3.

Taken with Pal. L. 4.

Text-books: *Text-book of Paleontology*, Zittel-Eastman; *Manual of Paleontology*, Nicholson and Lydekker; *Vertebrate Paleontology*, Woodward.

Elect. Junior Year, Second Semester, 2 hours.

Pal. 5 **Paleobotany.**

Preparation required: Geol. 7, 8, Pal. 1, 2, Pal. L. 1, 2.

Taken with Pal. L. 5.

Text-books: *Fossil Plants*, Seward; *Studies in Fossil Botany*, Scott.

Elect. Senior Year, First Semester, 2 hours.

Pal. 6. **Paleobotany.**

Preparation required: Pal. 5, Pal. L. 5.

Taken with Pal L. 6.

Text-book: *Fossil Botany*, Solms-Laubach.

Elect. Senior Year, Second Semester, 2 hours.

Pal. 7. **Paleobotany.**

Preparation required: Pal. 6, Pal. L. 6.

Graduate Work, First Semester, 2 hours.

Pal. 8. **Paleobotany.**

Preparation required: Pal. 7.

Graduate Work, Second Semester, 2 hours.

Pal. 9. **Paleontology.**
Preparation required: Pal. 4, Pal. L. 4.
Graduate Work, First Semester, 2 hours.

Pal. 10. **Paleontology.**
Preparation required: Pal. 9.
Graduate Work, Second Semester, 2 hours.

PALEONTOLOGICAL LABORATORY.

Pal. L. 1. **Paleontological Laboratory.**
Taken with Geol. 7, Pal. 1.
M. Geol. Sophomore Year, First Semester, 4 hours.

Pal. L. 2. **Paleontological Laboratory.**
Preparation required: Pal. 1, Pal. L. 1.
Taken with Geol. 8, Pal. 2.
M. Geol. Sophomore Year, Second Semester, 4 hours.

Pal. L. 3. **Paleontological Laboratory.**
Preparation required: Geol. 8, Pal. 2, Pal. L. 2.
Taken with Pal. 3.
Elect. Junior Year, First Semester, 4 hours.

Pal. L. 4. **Paleontological Laboratory.**
Preparation required: Pal. 3, Pal. L. 3.
Taken with Pal. 4.
Elect. Junior Year, Second Semester, 4 hours.

Pal. L. 5. **Paleobotanical Laboratory.**
Preparation required: Geol. 7, 8.
Taken with Pal 5.
Elect. Senior Year, First Semester, 4 hours.

Pal. L. 6. **Paleobotanical Laboratory.**
Preparation required: Pal. L. 5.
Taken with Pal. 6.
Elect. Senior Year, Second Semester, 4 hours.

Pal. L. 7. **Paleobotanical Laboratory.**
Preparation required: Pal. L. 6.
Taken with Pal. 7.
Graduate Work, First Semester, 4 hours.

Pal. L. 8. **Paleobotanical Laboratory.**
Preparation required: Pal. L. 7.
Taken with Pal. 8.
Graduate Work, Second Semester, 4 hours.

Pal. L. 9. **Paleontological Laboratory.**
Preparation required: Pal. 4., Pal L. 4.
Taken with Pal. 9.
Graduate Work, First Semester, 4 hours.

Pal. L. 10. **Paleontological Laboratory.**
Preparation required: Pal. L. 9, Pal 9.
Taken with Pal. 10.
Graduate Work, Second Semester, 4 hours.

Pal. L. 11. **Paleontological Laboratory.**
Taken with Pal. L. 1.
Elect. Sophomore Year, First Semester, 2 to 12 hours.

Pal. L. 12. **Paleontological Laboratory.**
Taken with Pal. L. 2.
Elect. Sophomore Year, Second Semester, 2 to 12 hours.

Pal. L. 13. **Paleontological Laboratory.**
Taken with Pal. L. 3.
Elect. Junior Year, First Semester, 2 to 12 hours.

Pal. L. 14. **Paleontological Laboratory.**
Taken with Pal. L. 4.
Elect. Junior Year, Second Semester, 2 to 12 hours.

Pal. L. 15. **Paleontological Laboratory.**
Preparation required Pal. L. 4.
Elect. Senior Year, First Semester, 2 to 12 hours.

Pal. L. 16. **Paleontological Laboratory.**
Preparation required: Pal. L. 4.
Elect. Senior Year, Second Semester, 2 to 12 hours.

Pal. L. 17. **Paleontological Laboratory.**
Taken with Pal. L. 9.
Graduate Work, First Semester, 2 to 12 hours.

Pal. L. 18. **Paleontological Laboratory.**
Taken with Pal. L. 10.
Graduate Work, Second Semester, 2 to 12 hours.

Pal. L. 19. **Paleobotanical Laboratory.**
Taken with Pal. L. 7.
Graduate Work, First Semester, 2 to 12 hours.

Pal. L. 20. **Paleobotanical Laboratory.**
Taken with Pal. L. 8.
Graduate Work, Second Semester, 2 to 12 hours.

Pal. L. 21. **Practical Work in Paleontology.**
Preparation required: Pal. L. 1, 2.
Elect. Sophomore Year, Summer Vacation, 10 weeks.

Pal. L. 22. **Practical Work in Paleontology.**
Preparation required: Pal. L. 1, 2.
Elect. Junior Year, Summer Vacation, 10 weeks.

Pal. L. 23. **Practical Work in Paleontology.**
Preparation required: Pal. L. 1, 2.
Elect. Senior Year, Summer Vacation, 10 weeks.

Pal. L. 24. **Practical Work in Paleontology.**
Preparation required: Pal. L. 1, 2.
Graduate Work, Summer Vacation, 10 weeks.

In the above laboratory courses in Paleontology and Paleobotany the object is to familiarize the student with the distinguishing features of the more important groups of fossils and to teach him the method of separating one formation from another by the aid of its fossil remains.

As laboratory manuals there are employed: *Invertebrate Paleontology,* Woods; *Vertebrate Paleontology,* Woodward; *Text-book of Paleontology,* Zittel-Eastman; *Manual of Paleontology,* Nicholson and Lydekker; *Fossil Botany,* Solms-Laubach; *Fossil Plants,* Seward; *Studies in Fossil Botany,* Scott; *Text-book of Geology,* Geikie; *Manual of Geology,* Dana, and the Paleontological Publications of the United States and the various states, especially New York and Pennsylvania.

PETROGRAPHY.

This group is considered here under two heads: (1) Optical and Microscopical Mineralogy and (2) Microscopical Petrography.

Optical and Microscopical Mineralogy.—Under this head are treated the various optical and other characteristics of minerals as revealed by the microscope. Alterations of minerals are especially studied, owing to their importance in the subject of Mining Geology and Petrography. The lectures given are chiefly devoted to the description and use of the microscope as a simple instrument and as a piece of optical apparatus for the determination of minerals and rocks. This part of the work will comprise the use of the petrographical microscope in common and polarized light, both as a microscope and as a polariscope; the chemical properties of minerals as determined under the microscope; and the distinguishing characters of important rock-forming minerals and their alterations.

These lectures are intended to give a clear and suitable introduction to the subject of Microscopical and Optical Mineralogy, which shall be adapted to the needs of geologists, civil and mining engineers, chemists, metallurgists, teachers, architects, and others who may need a good working or practical knowledge of the subject.

Microscopical Petrography.—Under this head instruction is given by means of lectures and laboratory practice upon the microscopical characters of rocks, as revealed in their thin sections. It is based on the earlier instruction in Macroscopical Petrography and the preceding Optical and Microscopical Mineralogy. It is intended not only to assist the student to name the rocks, but also to enable him to understand better the metamorphism of rocks and the origin and structure of ores and other useful geological deposits.

Pet. 1. **Optical Mineralogy and Microscopical Mineralogy and Petrography.**

Preparation required: Min. L. 7, Geol. 6, Mine. 1, M. Geol. 1.
Taken with Pet. L. 1.

Text-books: *Rock Minerals*, Iddings; *Minerals in Rock Sections*, Luquer; and *Manual of Microchemical Analysis*, Behrens.

E. Geol., M. Geol. Junior Year, First Semester, 3 hours.

Pet. 2. **Microscopical Petrography.**

Preparation required: Pet. 1, Pet. L. 1.
Taken with Pet. L. 2.

Text-books: *Text-book of Petrology*, Hatch; *Petrology for Students*, Harker; and *Handbook of Rocks*, Kemp.

E. Geol., M. Geol. Junior Year, Second Semester, 3 hours.

Pet. 3. **Origin of Minerals, Rocks, and Ore Deposits—their Alterations, Relations, and Classifications.**
Preparation required: Pet. 2, Pet. L. 2.
Taken with Pet. L. 3.

Text-books: *Rocks, Rock Weathering and Soils,* Merrill; *Metamorphism,* Van Hise.

E. Geol., M. Geol. Senior Year, First Semester, 3 hours.

Pet. 4. **Origin of Minerals, Rocks, and Ore Deposits—their Alterations, Relations, and Classifications—Continued.**
Preparation required: Pet. 3, Pet. L. 3.
Taken with Pet. L. 4, Geol. 14.

Text-books: *Rocks, Rock Weathering and Soils,* Merrill; *Metamorphism,* Van Hise.

E. Geol., M. Geol. Senior Year, Second Semester, 3 hours.

PETROGRAPHICAL LABORATORY.

Pet. L. 1. **Petrographical Laboratory.**
Preparation required: Min. L. 7, Geol. 6, Mine. 1, M. Geol. 1.
Taken with Pet. 1.

E. Geol., M. Geol. Junior Year, First Semester, 4 hours.

Pet. L. 2. **Petrographical Laboratory.**
Preparation required: Pet. 1, Pet. L. 1.
Taken with Pet. 2.

E. Geol., M. Geol. Junior Year, Second Semester, 4 hours.

Pet. L. 3. **Petrographical Laboratory.**
Preparation required: Pet. 2, Pet. L. 2.
Taken with Pet. 3.

E. Geol., M. Geol. Senior Year, First Semester, 6 hours.

Pet. L. 4. **Petrographical Laboratory.**
Preparation required: Pet. 3., Pet. L. 3.
Taken with Geol. 14, Pet. 4.

E. Geol., M. Geol. Senior Year, First Semester, 6 hours.

Pet. L. 5. **Petrographical Laboratory.**
Taken with Pet. L. 1.

Elect. Junior Year, First Semester, 2 to 12 hours.

Pet. L. 6. **Petrographical Laboratory.**
Taken with Pet. L. 2.

Elect. Junior Year, Second Semester, 2 to 12 hours.

Pet. L. 7.	**Petrographical Laboratory.**
	Taken with Pet L. 3.
Elect.	Senior Year, First Semester, 2 to 12 hours.
Pet. L. 8.	**Petrographical Laboratory.**
	Taken with Pet. L. 4.
Elect.	Senior Year, Second Semester, 2 to 12 hours.
Pet. L. 9.	**Research Work in Petrography.**
	Preparation required: Pet. 4, Pet. L. 4.
	Graduate Work, First Semester, 4 to 12 hours.
Pet. L. 10.	**Research Work in Petrography.**
	Preparation required: Pet. L. 9.
	Graduate Work, Second Semester, 4 to 12 hours.
Pet. L. 11.	**Petrographical Field Work.**
	Preparation required: Pet. 2, Pet. L. 2.
Elect.	Junior Year, Summer School, 100 hours.
Pet. L. 12.	**Petrographical Field Work.**
	Preparation required: Pet. 4, Pet. L. 4.
Elect.	Senior Year, Summer School, 100 hours.
Pet. L. 13.	**Petrographical Field Work.**
	Preparation required: Pet. 2, Pet. L. 2.
Elect.	Junior Year, Summer Vacation, 10 weeks.
Pet. L. 14.	**Petrographical Field Work.**
	Preparation required: Pet. 4, Pet. L. 4.
Elect.	Senior Year, Summer Vacation, 10 weeks.
Pet. L. 15.	**Petrographical Field Work.**
	Preparation required: Pet. 4, Pet. L. 4.
Elect.	Graduate Work, Summer Vacation, 10 weeks.

For descriptions of the work available for students in the School of Mines and Metallurgy not given in that School, see the General Catalog or the Fasciculus of the School in which the subject in question belongs.

SHORT COURSES IN MINING.

To meet the needs of students of age and experience who desire a mining or metallurgical education, but who are unable to take the complete four years' courses, and such others as wish to prepare for the examinations of Mine Inspectors, Foremen, and Fire Bosses, courses of instruction have been provided covering two years. These courses enable the student to obtain instruction in Crystallography, Mineralogy, Petrography, General and Field Geology, Mining Geology, Mining, Ore Dressing and Coal Washing, Trigonometry, Plane and Mine Surveying, General Chemistry, Qualitative and Quantitative Chemical Analysis, Drawing, Designing, Assaying, Metallurgy, Carpentry, Wood Turning, Forging, Pattern Making, Foundry, Machine Tool Work, etc., etc. The requirements for admission to this course are the same as those for the regular four years' course. It is intended to prepare the student for general mining, metallurgical, assaying, and geological work.

In order to meet the needs of different students and to give some general training, much elective work is offered, and a student in one year is allowed to elect any work in the same semester of the other year, or of any year in the four years' courses that he is properly prepared to take. Every student is required to take each semester at least twenty-three periods, including the required work, and also two summer schools of one hundred hours each.

The electives need to be selected with care and with reference to the results desired. The Dean and the other instructors are always willing to assist the students in their selections, and every schedule has to be approved by the Dean before it can stand.

These electives are so arranged to offer to students taking a short course the choice of one of scores of different courses which could easily be mapped out and offered as separate rigid courses of the usual type. This system is adopted as saving space and as really being much more satisfactory and advantageous in bringing about the desired results—hard and earnest work, and practically equivalent courses.

A student completing a course will receive a certificate to that effect on his making application to the Registrar of the college.

The schedule of studies is as follows:

SHORT COURSES IN MINES AND METALLURGY.

FIRST YEAR.

FIRST SEMESTER

Class Room Work, (Required 10 Periods).

Geol. 6.	General and Field Geology (3).
Min. 1.	Crystallography and Mineralogy (2).
Mat. 1.	Trigonometry, Plane and Spherical (5).

Practicums, (Required 9 Periods).

Dr. 2.	Mechanical Drawing and Designing (5).
Min. L. 5.	Crystallography and Mineralogy (7).
G. Lab. 1.	Field Geology, Geological Surveying and Mapping (6), [Geol. 6.]

Electives, (Required 4 Periods).

ELECTIVE WORK.

Class Room Work:

En. 1.	Rhetoric (5).
Fr. 1.	French (4).
Ger. 1.	German (4).
Sp. 1.	Spanish (4).
Pal. 1.	Paleontology (1), [Pal. L. 1.]
Geol. 3.	Elements of Physical Geography (2), Geol. 6, [Min. L. 5].
Geol. 7.	Paleozoic Geology (2), [Min. L. 5, Geol. 6, G. Lab. 1, Pal. L. 1].

Practicums:

F. Dr. 1.	Freehand Drawing (2).
Dr. 2.	Mechanical Drawing and Designing (2 to 12).
Zo. 1.	Elementary Zoology (4).
Sh. Pr. 1 to 7.	Carpentry (2 to 8).
Sh. Pr. 8, 9.	Wood Turning (7-0 or 8-0).
Sh. Pr. 11, 14.	Forging (2 to 6).
Min. L. 9.	Mineralogy and Petrography (2 to 12), [Min. L. 5].

Pal. L. 1.	Paleontology (4), [Geol. 7, Pal. 1.]
Pal. L. 11.	Palentology (2 to 12), [Pal. 1.]
G. Lab. 3.	Field Geology, Geological Surveying and Mapping (2 to 12), [G. Lab. 15].

SECOND SEMESTER.

Class Room Work, (Required 10½ Periods).

Ch. 1.	General Chemistry and Qualitative Analysis (5-4), [Ch. 2].
Mine 1.	The Principles of Mining (3), Geol. 6, [Min. L. 6].
M. Geol. 1.	Mining (Economic) Geology (3), Geol. 6, [Min. L. 6].

Practicums, (Required 7½ Periods)

Ch. 2.	Elementary Chemistry and Qualitative Analysis (4-6), [Ch. 1].
Min. L. 6.	Mineralogy and Petrography (10-6), [Ch. 1, 2].
Sur. 1.	Surveying (0-4), Mat. 1.

Electives, (Required 5 Periods).

ELECTIVE WORK

Class Room Work:

En. 2.	Argumentation (2), En. 1.
Fr. 2.	French (4), Fr. 1.
Ger. 2.	German (4), Ger. 1.
Sp. 2.	Spanish (4), Sp. 1.
Mat. 2.	Analytic Geometry (5), Mat. 1.
Bot. 1.	Botany (2).
Geol. 4.	Advanced Physical Geography (2), Geol. 3, [Min. L. 5].
Geol. 8.	Mesozoic and Cenozoic Geology (2), Geol. 7, [G. Lab. 2, Pal. 2, Pal. L. 2].
Geol. 13.	Volcanoes and Earthquakes (2), Geol. 6.
Pal. 2.	Paleontology (1,) [Geol. 8, Pal. L. 2].

Practicums:

Fr. 2a.	French Sight Reading (0-1), Fr. 2.
Ger. 2a.	German Sight Reading (0-1), Ger. 2.
Sp. 2a.	Spanish Sight Reading (0-1), Sp. 2.
Bot. 2.	Botany (6), [Bot. 1].
M. Des. 3.	Elementary Design (10), Dr. 2.
Sh. Pr. 1 to 7.	Carpentry (2 to 8).

Sh. Pr. 8, 9.	Wood Turning (7-0), or (8-0).
Sh. Pr.11 to 14.	Forging (2 to 6).
Sh. Pr. 15.	Metal Work (2).
Sh. Pr.16,18,19.	Pattern Making (2 to 0-7), Carp. 73 hours and Wood Turning 55 hours.
Sh. Pr.22,24,25.	Foundry (0-2 to 2), [Sh. Pr. 16, 18 or 19].
Sh. Pr. 28.	Chipping, Filing, and Pipe Fitting (2).
Sh. Pr.29 to 36.	Machine Tool Work (2 to 14), Forging 64 hours.
Min. L. 10.	Mineralogy and Petrography (2 to 12), [Min. L. 6].
Pal. L. 2.	Paleontology (4), Pal. 1, Pal. L. 1, [Geol. 8, Pal. 2].
Pal. L. 12.	Paleontology (2 to 12), [Geol. 8, Pal. 2].
G. Lab. 2.	Field Geology and Geological Surveying and Mapping (6) Geol. 6.
G. Lab. 4.	Field Geology, Geological Surveying and Mapping (2 to 12), G. Lab. 1.
M. G. L. 1.	Mining Geological Laboratory (2 to 12), [M. Geol. 1].
M. Lab. 1.	Mining Laboratory and Design (4 to 12), Dr. 2, Mat. 1, [Mine 1].

SUMMER SCHOOL.

Practicum, (Required 100 hours or 3 Periods).

Sur. 2.	Surveying (100 hours).

ELECTIVE WORK—SUMMER VACATION.

Practicums, (16 Periods).

M. Lab. 13.	Practical Work in Surveying (10 weeks).
M. Lab. 14.	Practical Work in Mining (10 weeks).
G. Lab. 12.	Practical Work in Geology (10 weeks), G. Lab. 1, Geol. 6.
Pal. L. 21.	Practical Work in Paleontology (10 weeks), Pal. L. 1.

SECOND YEAR.

FIRST SEMESTER

Class Room Work, (Required 9 Periods).

Min. 2.	Mineralogy and Petrography (1), [Min. L. 7, Min. 1, Min. L. 6.
Met. 4.	The Principles of Metallurgy (3), Ch. 1, 2.
Law 3.	Principles of Law, and Law of Contracts (2), Mine 1, M. Geol. 1.
Law 4.	Mining Law and Law of Mining Injuries (3), Law 3.

Practicums, (Required 10 Periods).

Met. L. 17.	Assaying, Fire (6), Ch. 2, [Min. L. 7].
Min. L. 7.	Mineralogy and Petrography (10), Ch. 1, 2, [Min. 1].
Met. L. 1.	General Metallurgical Experimentation (4), Ch. 1, 2, [Met. 4], Min. L. 7.

Electives, (Required 4 Periods).

Class Room Work:

En. 7.	American Literature (4), En. 4.
Fr. 3.	French (3), Fr. 2.
Ger. 3.	German (3), Ger. 2.
Sp. 3.	Spanish (3), Sp. 2.
Mat. 3.	Advanced Algebra (3).
Mat. 4.	Differential Calculus (2), Mat. 2, [Mat. 3].
Dr. 14.	Descriptive Geometry (1), Dr. 2, Mat. 2, [Dr. 15].
Phy. 1.	Mechanics and Heat (4), Mat. 1.
Bot. 3.	Botany (3), Bot. 1.
For. 1.	Timber Physics (1).
Zo. 2.	General Biology (2).
Zo. 6.	Zoology (4).
Mchs. 1.	Elementary Mechanics (3), Mat. 1.
Ht. Eng. 1.	Steam Engines (2).
Ht. Eng. 3.	Boilers (1).
Met. 7.	Gas Producers (2), [Met. 4].
Met. 8.	Metallography—the Microscopic Structure of Metals and Alloys (1), [Met. 4, Met. L. 6].
Met. 9.	Blast Furnaces, Foundry Work, Cast Iron, Malleable Cast Iron, and Wrought Iron (3), [Met. 4].
Met. 11.	The Metallurgy of Copper (2), [Met. 4].
Met. 12.	Metallurgy of Lead (2), [Met. 4].
Met. 15.	Alloys—their Preparation and Properties (1), [Met. 4].
Ore 1.	Principles of Ore Dressing and Coal Washing (2), [Met. 4].
Ore 2.	Ore Dressing Operations and Machinery (2), [Met. 4].
Ore 3.	Coal Washing and Preparation for Market (2), [Met. 4].
Pet. 1.	Optical and Microscopical Mineralogy and Petrography (3), Geol. 6, [Pet. L. 1].
Pal. 3.	Paleontology (2), Pal. 2, Pal. L. 1, Geol. 8, [Pal. L. 3].

Pal. 5.	Paleobotany (2), Geol. 6, [Pal. L. 5].
Geol. 5.	Advanced Physical Geography (2), Geol. 4.
Geol. 9.	Glacial Geology (2), Geol. 8.
Geol. 11.	Geology of the United States (2), Geol. 6, 7, [Geol. 8].
M. Geol. 2.	Memetallites or Non-Metalliferous Deposits (2), M. Geol. 1.
M. Geol. 9.	Building and Ornamental Stones (2), M. Geol. 1.
M. Geol. 10.	Precious Stones or Gems (2), M. Geol. 1, [Pet. 1, Pet. L. 1].
M. Geol. 11.	Clays—their Occurrence, Properties, and Uses (2), M. Geol. 1, [Pet. 1, Pet. L. 1].
M. Geol. 13.	Coal (2), M. Geol. 2, [Pet. 1, Pet. L. 1].
M. Geol. 17.	Iron Ores (2), M. Geol. 1, Mine 1.
Mine 2.	Mine Gases, Ventilation, Lighting, Mine Accounts, "Laying out" of Mines and Underground and Surface Plants (3), Mine 1, Mat. 1.
Mine 4.	Coal Mining (2), Mine 1.
Mine 6.	Metal Mining (2), Mine 1.
Mine 9.	Mine Drainage and Pumping (2), Mine 1.
Mine 12.	Mining and Ventilating Machinery (2), Mine 1.
Mine 15.	Mine Hoisting and Haulage (2), Mine 1.
Mine 17.	Exploitation and Supporting, including Timbering (2), Mine 1.
Law 5.	Law relating to Oil and Gas (2), [Law 3, 4].

Practicums:

Fr. 3a.	French (1), [Fr. 3].
Ger. 3a.	German (1), [Ger. 3].
Sp. 3a.	Spanish (1), [Sp. 3].
Dr. 15.	Descriptive Geometry (4), Dr. 2, Mat. 2, [Dr. 14].
Phy. 5.	Physical Laboratory (4), Mat. 1.
Ch. 3, 4.	Qualitative Chemical Analysis (4 1-2 or 7), [Ch. 1, 2].
Bot. 4.	Botany (4), Bot. 2, [Bot. 3].
For. 2.	Timber Physics (4), [For. 1].
Zo. 3.	Biology (3), [Zo. 2].
Zo. 7.	Zoology (6), [Zo. 6].
Sh. Pr.29 to 36.	Machine Tool Work (2 to 14), Forging 64 hours.

Met. L. 6.	Metallography—Polishing, Etching, Microscopic study, etc. (4), [Met. 4, Met. 8].
Met. L. 7.	Experiments with Iron and Steel (4), [Met. 4, 8].
Met. L. 9.	Experiments in Smelting and Refining (4), [Met. 4, Met. 10 or 11].
Met. L. 14.	Metallurgical Designing (4), [Met. 4].
Met. L. 16.	Metallurgical Calculations (3), [Met. 4].
Met. L. 29.	Assaying of Ores, Slags, Fluxes, and Metallurgical Products (6), Ch. 2, [Min. L. 7, Ch. 3 or 4, [Met. 4].
Ore L. 2.	Ore Dressing Machinery (6), Ore 2.
Ore L. 3.	Coal Washing and Preparation (6), Ore 3.
Min. L. 11.	Mineralogy and Petrography (2 to 12), [Min. L. 7].
Pet. L. 5.	Petrographical Laboratory (2 to 12), Min. L. 8, Geol. 6, Mine 1, M. Geol. 1. [Pet. 1.].
Pal. L. 13.	Paleontology (2 to 12), [Pal. L. 1].
Pal. L. 19.	Paleobotany (4 to 12), [Pal. 5].
G. Lab. 5.	Field Geology, Geological Surveying and Mapping (4 to 12), G. Lab. 1.
M. G. L. 2.	Mining Geological Laboratory (2 to 12), M. Geol. 2].
M. G. L. 9.	Mining Geological Laboratory (2 to 12), M. Geol. 9].
M. G. L. 13.	Mining Geological Laboratory (2 to 12), [M. Geol. 13].
M. Lab. 2.	Mining Laboratory and Design (4 to 12), Dr. 2, Mat. 1, Mine 1.
M. Lab. 11.	Mine Hoisting and Haulage (4 to 12), [Mine 15].
M. Lab. 12.	Mine Gases, Ventilation, Lighting, etc. (4 to 12), [Mine 2].

SECOND SEMESTER

Class Room Work, (Required 6½ Periods).

Mine 11.	Mine Sampling, Valuation, Economics, Accidents, First Aid to Injured, etc. (2), Mine 1.
Mine 21.	Mine Labor, Management, etc. (3), Mine 1, Law 3, 4.
Sur. 9.	Mining Surveying (2-1), Sur. 2, [Sur. 10].

Practicums, (Required 4½ periods).

Sur. 10.	Mining Surveying (2-4), Sur. 2, [Sur. 9].
M. Lab. 6.	Mining Laboratory and Design (6), Mine 1.

Electives, (Required 12 Periods).

ELECTIVE WORK

Class Room Work:

Fr. 4.	French (3), Fr. 3.
Ger. 4.	German (3), Ger. 3.
Sp. 4.	Spanish (2), Sp. 3.
Mat. 5.	Differential and Integral Calculus (5), Mat. 4.
Dr. 17.	Descriptive Geometry (2-0), Dr. 2, Mat. 2, [Dr. 16].
Phy. 2.	Electricity, Sound, and Light (4), Mat 1.
Phy. 3.	Electricity (4), [Mat. 5].
Ch. 5.	Quantitative Chemical Analysis (1), Ch. 3 or 4, [Ch. 6].
Bot. 5.	Botany (5), Bot. 3.
Bot. 7.	Bacteriology (3).
Zo. 4.	General Biology (2), Zo. 2.
M. Des. 2.	Mechanics of Machinery (2), Dr. 2, Mchs. 1.
Ht. Eng. 2.	Steam Engines and Boilers (2).
Ht. Eng. 4.	Mechanical Engineering of Power Plants (2), Ht. Eng. 1.
Met. 3.	Metallurgy of Copper, Lead, Gold, Silver, Zinc, Nickel, etc., Met. 4.
Met. 5.	Furnaces, Fuels, Calorimetry, Pyrometry, etc. (3), Met. 4.
Met. 6.	Refractory Materials — their Manufacture, Properties, and Uses, (1), Met. 4.
Met. 10.	Steel—Its Methods of Manufacture, Properties, Heat Treatment, and Methods of Working (4), Met. 9.
Met. 13.	Metallurgy of Gold and Silver (2), Met. 4, Ore 1 or 2.
Met. 14.	Metallurgy of Zinc, Tin, Antimony, Bismuth, Nickel, etc. (2), Met. 4.
Met. 16.	Electro-Metallurgical Processes (3), Met. 4.
Ore 4.	The Milling of Gold and Silver Ores (2), Ore 2.

Ore 5.	Hydro-Metallurgy—the Cyanide, Chlorination, Hyposulphate, and other Leaching Processes (2).
Pet. 2.	Microscopical Petrography (3), Pet. 1, [Pet. L. 2].
Pal. 4.	Paleontology (2), Pal. 3, [Pal. L. 4].
Pal. 6.	Paleobotany (2), Pal. 5, [Pal. L. 20].
Geol. 10.	Prehistoric Man (2), Geol. 6, 7, 8.
Geol. 14.	Azoic or Archean Geology (2), Geol. 6, [Pet. 2].
M. Geol. 3.	Metallites or Metalliferous Deposits (3), Geol. 6, M. Geol. 1.
M. Geol. 5.	Ore Deposits of United States (2), [M. Geol. 3].
M. Geol. 12.	Limes, Mortars, Plasters, Cements, etc. (2), M. Geol. 11.
M. Geol. 14.	Petroleum, Natural Gas, Asphaltum, and other Hydrocarbons (2), M. Geol. 13.
M. Geol. 15.	Road and Refractory Materials, Abrasives, Fluxes, Phosphates, etc. (2), M. Geol. 9.
M. Geol. 18.	Copper Deposits (2), M. Geol. 17.
M. Geol. 22.	Theories of Ore Deposits (2), [M. Geol. 3, Pet. L. 2].
Mine 2.	Mine Gases, Ventilations, Lighting, etc. (3), Mine 1.
Mine 3.	Mine Calculations and Estimates (2), Mine 1.
Mine 5.	Coal Mining (2), Mine 4.
Mine 7.	Metal Mining (2), Mine 1.
Mine 8.	Hydraulic Mining and Dredging (2), Mine 1.
Mine 13.	Power Generation and Transmission in Mines (2), Mine 1.
Mine 14.	Mine Drainage and Pumping (2), Mine 1.
Mine 16.	Breaking Ground (Explosives), Boring and Shaft Sinking (2), Mine 1.
Mine 18.	Advanced Mine Surveying (1), Sur. 9, 10, [M. Lab. 15].
Law 5.	Mining Law, continued (3), Law 3, 4.
Law 6.	Law of Negligence and of Personal Injuries in Mines (3), Law 3, 4.

Practicums:

En. 9.	Bibliography (2).
Dr. 16.	Descriptive Geometry (2-6), Dr. 2, Mat. 2, [Dr. 17].

Phy. 5.	Physical Laboratory (4), [Mat. 5].
Phy. 7.	Physical Laboratory (2), Met. 1, [Phy. 2].
Ch. 6.	Quantitative Chemical Analysis (8-0 to 12), [Ch. 5].
Bot. 6.	Botany (8).
Bot. 8.	Bacteriology (5).
Zo. 5.	Biology (2).
Sh. Pr.29 to 36.	Machine Tool Work (2 to 14), Forging 64 hours.
Met. L. 2.	General Metallurgical Exprimentation (4), Met. 4, Met. L. 1.
Met. L. 4.	Fuels—Calorimetry, Coking, Physical Tests and Analyses (4), [Met. 5].
Met. L. 5.	Refractory Materials—their Manufacture and Testing (4), Met. 2, [Met. 6].
Met. L. 8.	Experiments with Iron and Steel (4), [Met. 8].
Met. L. 10.	Experiments in Smelting and Refining (4), [Met. 13 or 14].
Met. L. 16.	Electro-Metallurgical Operations (6), Met. 4, [Met. 16].
Met. L. 15.	Metallurgical Designing (4), Met. L. 13.
Met. L. 19.	Assaying, Fire, continued (6), Met. L. 16.
Met. L. 21.	Assaying of Ores, Slags, Fluxes, and Metallurgical Products (6), Met. L. 20.
Ore L. 3.	Gold and Silver Milling (6), [Ore 4].
Ore L. 4.	Hydrometallurgy of Gold, Silver, etc. (6), [Ore 5].
Min. L. 11.	Mineralogy and Petrography (2 to 12), [Min. L. 7].
Pet. L. 2.	Petrographical Laboratory (4), Pet. L. 1, [Pet. 2].
Pet. L. 6.	Petrographical Laboratory (2 to 12), [Pet. L. 2].
Pal. L. 4.	Paleontological Laboratory (4), [Pal. 4].
Pal. L.14.	Paleontological Laboratory (2 to 12), [Pal. L. 4].
Pal. L. 20.	Paleobotanical Laboratory (2 to 12), Pal. L.19.
G. Lab. 6.	Field Geology and Geological Surveying and Mapping (4 to 12), G. Lab. 1 or 2.
M. G. L. 10.	Mining Geological Laboratory (2 to 12), [M. Geol. 10].
M. G. L. 13.	Mining Geological Laboratory (2 to 12), [M. Geol. 13].

M. G. L. 14.	Mining Geological Laboratory (2 to 12), [M. Geol. 14].
M. Lab. 4.	Mining Laboratory and Design (2 to 12), M. Lab. 6.
M. Lab. 13.	Breaking Ground (Explosives), Boring and Shaft Sinking (2 to 12), [Mine 16].

SUMMER SCHOOL.

Practicums, (Required 100 hours or 3 Periods).

Sur. 11.	Geodetic and Topographic Surveying (100 hours), Sur. 8 to 10.
M. Lab. 18.	Mining Surveying (100 hours), Sur. 8 or 9.
Ch. 20.	Quantitative Chemical Analysis (100 hours), Ch. 5, 6.
Met. L. 28.	Metallurgical Inspection Trip (100 hours), Met. 4 and 5 or 6.
Pet. L. 11.	Petrographical Field Work (100 hours), Pet. 2, Pet. L. 2.
G. Lab. 9.	Geological Field Work (100 hours), Geol. 6, G. Lab. 1.
M. G. L. 23.	Field Work in Mining Geology (100 hours), Min. L. 7, M. Geol. 1, Geol. 6, G. Lab. 1.

SUMMER VACATION.

Practicums, (16 Periods).

Min. L. 23.	Practical Work in Mineralogy (10 weeks), Min. L. 8.
Met. L. 22.	Practical Work in Metallurgy (10 weeks).
Met. L. 24.	Practical Work in Assaying (10 weeks).
Pet. L. 13.	Petrographical Field Work (10 weeks), Pet. 2, Pet. L. 2.
Ore L. 5.	Practical Work in Ore Dressing (10 weeks).
Ore L. 6.	Practical Work in Coal Washing (10 weeks).
G. Lab. 13.	Practical Work in Geology (10 weeks), Geol. 6, G. Lab. 1.
Pal. L. 21.	Practical Work in Paleontology (10 weeks), Pal. L. 2.
M. G. L. 26.	Practical Work in Mining Geology (10 weeks), Min. L. 8.
M. Lab. 23.	Practical Work in Mining (10 weeks), Mine 1.

SPECIAL STUDENTS IN MINING.

PERSONS of suitable age and experience will be admitted without examination to take such studies as the different instructors shall be satisfied they are qualified to pursue.

Experience with such students has shown that they make most valuable and energetic workers, and have a very beneficial influence upon the undergraduate students. This special work is designed for men of an active and practical business life, usually in some department of mining or metallurgy, who feel the need of further education that will assist them in their future work. Results have demonstrated that such an opportunity as is here afforded has been of distinct and lasting benefit to such students, oftentimes placing them upon a distinctly higher plane in life than otherwise they could have reached.

This work is also calculated to assist persons into whose hands has come the management of estates connected with mining industries, to whom a certain amount of knowledge of mining and allied subjects is not only useful but essential.

In the same way men engaged in prospecting have found the special study of Mineralogy and Mining Geology invaluable to them.

The School of Mines and Metallurgy especially desires to aid all who wish to increase their stock of knowledge in the subjects taught in it, and it will cordially welcome all such special students and give them every opportunity it can.

It is intended in this way to assist those who are preparing to pass examinations for the various positions of mine inspector, mine foreman, and fire boss. All persons who are thus interested in mining and allied work are allowed to enter at any time and to take any studies that they appear to be able to follow. They are permitted to remain as long as they wish, and are not under the operation of any college rules; but are expected to conduct themselves as good citizens and to attend to their selected work, or else to withdraw from the institution.

The class room work usually commences at the beginning of a semester and continues to its close, but if the student can profit by entering at other times and work can be arranged to meet his needs, there are no objections to his doing so. In the majority of the laboratories the work can commence at any period, and part or the entire time of the student devoted to it as may seem best. Thus, one having leisure at certain portions of the year can take up different portions of the work in successive years.

The class room work specially available includes General Geology, Mining Geology, Engineering Geology, Ore Dressing and Preparation of Coal for the Market, Surveying, Mine Surveying, the different branches of Mining, Mine Gases, Explosives, Mining Law and Management, the General Principles of Metallurgy, the properties and Utilization of Fuels, Refractory Materials and Alloys, the Metallurgy of Iron, Steel, Copper, Lead, Zinc, Nickel and the Minor Metals, etc., etc.

In the laboratories there will be taught the adjustment, manipulation, and use of the transit and other surveying instruments, the practical methods of discriminating and determining minerals, rocks, and fossils, Geological and Mine Surveying, and Mapping and Field Geology, Methods of Ore Dressing and "Laying-out" of Mine Plants (including tipples, head-frames, shaft houses, mill buildings, fans, bents, chutes, etc.); processes of testing fans, operating drills and other mine machinery, mine gases, etc.; work in fuel testing, including the determination of moisture, volatile hydrocarbons, fixed carbon and ash in coal, or proximate analyses; the determination of sulphur, the determination of the B. T. U. by means of the bomb calorimeter; tests to determine the effect of washing on coals; gas analysis both of furnace and flue gases, and the determination of the efficiency of furnaces; assaying, including the assay of gold, silver, and lead ores and furnace products by all known methods, and the wet methods of assaying ores, fluxes, slags, and furnace products, including analyses for iron, copper, lead, zinc, and other substances met with in Metallurgical work; Metallurgical Laboratory work includes work with the Le Chatelier and other pyrometers, the effects of heat treatment of iron and steel, the Microscopic Metallography of iron, steel and alloys, along with other typical metallurgical experiments. Opportunities are also given for carrying out tests on special processes of ore treatment, like the availability of the cyanide process for gold, etc.

All the School's work is freely available for use. No requirements will be made of the practical man who wishes to take advantage of these opportunities beyond that he shall be able to profit by the work he wishes to take and that he shall attend to it. No matter what has been his past work, or what his age is, if he has the ambition, energy, and perseverance to rise, the School will be only too glad to help him in every way it can.

LABORATORY CHARGES PER SEMESTER.

Met. L. 1, 2, 3, 4, 5, 6, 7 or 8	$5.00
Met. L. 9, 10	20.00
Met. L. 11, 20, 21, 22 or 23	10.00
Met. L. 17, 18 or 19	15.00
Met. L. 12, 13, 29, 30, 31 or 32; to be arranged by the School.	
Met. L. 14, 15 or 16	No fee
Ore L. 1, 3 or 4	15.00
Ore L. 2.	7.00
Mineralogy for each hour scheduled	.75

MILITARY DEPARTMENT

This Department is in charge of an officer of the regular army, detailed by the United States War Department as Professor of Military Science and Tactics.

The instruction is both theoretical and practical. Theoretical instruction includes a thorough course, confined to the first semester of the Freshman year, in Infantry Drill Regulations and Manual of Guard Duty, and a course for commissioned officers in the second semester in Field Service Regulations. Both courses are supplemented by lectures. Theoretical instruction is also given the Sophomore class in Firing Regulations for Small Arms in conjunction with the practical instruction.

Practical instruction includes instruction in the following:

Infantry.—School of the soldier, squad, company and battalion in close and extended order, with ceremonies of guard mounting, dress parades, reviews and inspections.

Artillery.—Manual of the piece and service of the foot battery. Manual of Guard Duty.—As much as it is practicable to give. Field Service Regulations—Advance and rear guards and outpost duty. Firing Regulations for Small Arms.—Practical instruction is given to members of the Sophomore class in regular range practice with the magazine rifle and service ammunition.

The National Government has furnished the College with 500 Krag-Jorgensen magazine rifles and the necessary accessories. The uniform is the dress uniform of the regular Infantry, the cost of which is no more than that of a good suit of civilian's clothes.

No exemption from military drill is granted to any male student except to members of the athletic squad whose names are certified to the Commandant of Cadets by the Faculty Athletic Committee.

The experience of the past shows that, unless a student is maimed or suffering from great physical weakness, the military drill is a benefit, and for weak constitutions, better medicine than a physician's prescription.

The object of military drill is not only to comply with the laws of Congress but to supply the State with a number of well-instructed young men capable of rendering intelligent, effective service in case of war or domestic riot.

GENERAL STATEMENTS

LIBRARIES AND READING ROOMS

THE Library of the College consists of a central or main collection, and nine department Libraries. The total number of volumes is about twenty-five thousand. The Main Library embraces scientific and technical works, covering especially the fields of mathematics, engineering, chemistry, physics, agriculture, and biology, in both English and foreign languages, forming the foundation of a good scientific library. There are also carefully selected works on history, economics, education and general literature. Department Libraries consist of books and periodicals constantly needed for laboratory work in several lines, and amount, in the aggregate, to forty-one hundred volumes. Yearly additions are made, but the funds for this purpose are at present inadequate.

The Carnegie building, in which the Library is accommodated, has proven its value and adaptableness to the needs of all. The massing of the books about a central reading room, and practically free access to the stack, give the student the best of opportunities to acquaint himself with books. A card catalogue by author, title, and subject is provided, and the student is urged to avail himself of its aid. A bibliography room furnishes indexes, lists, guides, bibliographies, and other aids to book selection.

The reading-rooms keep on file a select list of magazines, journals, proceedings and transactions of societies, etc., for the use of Faculty and students. The number of journals, general and technical, received at the College by subscription and exchange is at present approximately five hundred. Twelve daily papers are regularly filed in the Library, together with an ample list of weekly papers representing the various Counties of the Commonwealth.

The Library is open during the College year: Weekdays: 7:55 a. m. to 10 p. m. Sundays: 3:00 p.m. to 10 p. m.

The Library earnestly solicits gifts from Alumni and friends of the College. Lists of desired and desirable additions will be furnished intending donors by addressing the Librarian.

PHYSICAL CULTURE

One of the largest and best equipped gymnasiums in the State is provided for the physical welfare of students. The object of the work given in the physical training classes is not to develop a few fine gymnasts and athletes, but to give to every student a strong, well-developed body and a knowledge of the care of it. A thorough physical and medical examination is given each member of the Freshman and Sub-Freshman classes to discover whatever defects exist in the various organs of the body, and special exercises are prescribed for the strengthening and development of weak organs and muscles and the correction of defects and deformities. The course consists of medical, corrective, and classified gymnastics, elementary, intermediate, and advanced apparatus work, etc. Special instruction is given in Wrestling, Boxing, Fencing and Club Swinging.

The Sophomore, Freshman and Sub-Freshman classes are required to take two hours' gymnasium work each week. This training is also given to such members of the Senior and Junior Classes as may elect it.

Beaver Field, with its fine quarter-mile "cinder" track, baseball diamond, football field, tennis-courts, and track-house (provided with baths, dressing-rooms, lockers, etc.), offers the very best facilities for athletic work. A fine grand-stand accommodates the many patrons of the different games and sports.

SUMMER SCHOOL

A Summer School of two weeks directly follows Commencement. The time is occupied exclusively with practical training in the laboratories, shops and fields; and all students of the Freshman, Sophomore, and Junior classes who take an engineering course, the courses in Mines and Metallurgy, the course in Industrial Chemistry, or the course in Agriculture, are required to attend. The object of this arrangement is to allow a period of uninterrupted practice in the machine shops, in the surveying of fields and mines, in making the necessary computations, and in other lines of practical or experimental work, which cannot be secured in the ordinary course of daily employment during term time.

RELIGIOUS EXERCISES

The Faculty and students meet in the Auditorium at eight o'clock each week-day morning, except Saturday, for religious exercises, conducted by the President or the College Chaplain. On Sunday, preaching services are regularly conducted in the same place. Attendance on all these exercises is required of students, except such as are regularly excused to attend elsewhere with their parents or guardians.

RHETORICAL EXERCISES

All students except those of the Senior class are required to engage in Rhetorical exercises. These consist of declamations during the Freshman year, and debates and topical speeches during the Sophomore and Junior years. All original productions are submitted to the Instructor in English and Oratory for correction, and on each exercise the student receives instruction and drill in the art of delivery.

DISCIPLINE

The discipline of the College is intended to be strict, but reasonable and considerate. It assumes that students come here, not to spend their time in idleness, but to prepare themselves for useful and honorable careers in life. The aim of the Faculty is to lead students to cultivate habits of steady application, self-control, a high sense of honor, truthfulness, and an interest in maintaining the purity of the moral atmosphere of the Institution. Students whose influence, after fair trial, is found to be injurious to good scholarship or good morals are dropped from the Institution.

DEGREES

The degree of Bachelor of Science is conferred upon graduates from any of the four years' technical courses, from the General Science and the Latin Scientific Courses, and from the Course in Philosophy, the diploma mentioning the special line of work pursued. The degree of Bachelor of Arts is conferred upon graduates from the Classical Course, and the degree of Bachelor of Letters upon graduates from the Course in Language and Literature.

Advanced degrees are conferred on the following conditions:

I. The advanced degrees of Civil Engineer (C.E.), Mechanical Engineer (M.E.), Electrical Engineer (E.E.), *Engineer of Mines (E.M.), or Geological Engineer (G.E.), or Metallurgical Engineer (Met.E.), Master of Arts (M.A.), and §Master of Science (M.S.), respectively, will be conferred:

(*a*) Upon students who complete the appropriate undergraduate course in any of the above lines of study, and in addition pursue a successful course of graduate study for one year at this College in the same line of work, and submit a satisfactory thesis.

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* Those who complete the Engineering Courses in the School of Mines and Metallurgy.

§ Including those who complete the non-Engineering Courses in the School of Mines and Metallurgy.

The graduate course will be made up of a major and approved minor subjects; at least one-half of the student's time will be devoted to the major subject, the remaining time to the minors. The major subject must be selected from the work of the department in which the first degree was conferred; the minors will be assigned by the Faculty. A graduate in the Mechanical Engineering Department who is a candidate for the degree of M.E. may, however, take Electrical Engineering as a major, in which case the minors will be assigned in Mechanical Engineering work. The thesis must be written upon a topic relating to the major subject.

At present the following majors are offered in the different engineering departments:

FOR THE DEGREE OF CIVIL ENGINEER:

Railroad Engineering,
Structural Engineering,
Hydraulic Engineering,
Sanitary Engineering,
Geodesy.

FOR THE DEGREE OF MECHANICAL ENGINEER:

Steam Engineering,
Marine Engineering and Naval Architecture,
Mill Engineering,
Electrical Engineering (see foregoing paragraph),
Power Transmission,
Machine Design.

FOR THE DEGREE OF ELECTRICAL ENGINEER:

Electrical Transmission and Distribution of Energy,
Electrical Machine Design and Mechanical Application,
Electrical Lighting,
Electrical Railways,
Electrochemical Engineering,
Telephone Engineering.

For the Degree of Engineer of Mines, Geological Engineer, and Metallurgical Engineer:

Mining,
Ore Dressing,
Coal Washing,
Assaying,
Metallurgy,
Crystallography,
Mineralogy,
Petrography,
Geology,
Paleontology,
Mining Geology,
Mining Law.

(*b*) Upon graduates from this College who, with their application, present satisfactory evidence of having for three years successfully pursued professional work in the line of the course from which they were graduated, and who submit a satisfactory thesis on an approved professional subject.

The subject of the thesis to be submitted must be announced not later than January 1, in any year, and the thesis submitted not later than May 1.

(*c*) Upon graduates from this College in any Engineering Course who have had not less than five years' successful practice in the line of engineering in which the degree is desired, provided they have had the Mathematics and Mechanics of that undergraduate Course in Engineering, on compliance with requirements of thesis, etc.

2. In the case of graduates of this College applying for the degree of Master of Arts or Master of Science under (*a*), the requirement of residence may be waived on the following conditions:

(*a*) A course of study must be pursued continuously under the direction of the Faculty for two years after the application is filed and must amount to at least one five-hour course during that time;

(*b*) The candidates must pass examinations at such times and in such subjects as may be designated, not less than twice a year;

(*c*) Must show by an acceptable thesis ability to conduct original research; and

(*d*) Must, in the meantime, have successfully pursued professional work of an approved character in the line of the course chosen.

3. The fees for the degree of "Master" or "Engineer" are at present $15; of this sum $5 is required at the time of entrance upon the work, and the remainder when the thesis is presented. In case the thesis is not accepted, this latter portion of the fee will be refunded.

EXPENSES

Tuition: The tuition fee is $100, but all students residing in Pennsylvania are exempt from this fee.

Every student is required to deposit $5, at the beginning of each College year, as a security against damage.

An incidental fee of $35 a year is charged to all students except those holding Scholarships.

Rooms.—The charge for a room, heated, lighted, and partly furnished, accommodating two, is $50 a year for each occupant rooming in any of the College Dormitories.

Instruments.—All students whose course includes mechanical drawing should be prepared to purchase a set of instruments, tee-squares, triangles, etc., which will cost about $14.50.

Board.—The Dormitory (McAllister Hall) contains a Dining Hall capable of seating 800 people at one time. Board may be obtained at this hall at a moderate charge, the rate at present being $3 per week.

The College year is thirty-six weeks, not including the Summer School, following Commencement.

Furniture.—The furniture provided for students who room in the College dormitories consists of a bedstead, mattress, table and chair. The student provides all other articles, including pillow, bedding, wash-bowl, pitcher, mirror, etc.

Uniform.—Each student is required to drill during the Sub-Freshman, Freshman, and Sophomore years, and to provide himself with a uniform for this purpose. Measures are taken at the College, and orders filled by some approved maker, who is selected each year by the Executive Committee of the Board of Trustees, and who furnishes the suits at an important reduction from the usual retail rates.

Books and Stationery can be procured at the College at some reduction from retail prices.

CHARGES

The following table shows at a glance all fixed charges, except Laboratory fees, by semesters:

		First Semester	Second Semester
1.—Students not renting a College room.	Incidentals	$18 00	$17 00
	Gymnasium Fee....	5 00	5 00
	Library Fee	1 50	1 50
	Total............	$24 50	$23 50
2.—Students renting a College room, (with room-mate).	Incidentals	$18 00	$17 00
	Room Rent	27 00	23 00
	Gymnasium Fee....	5 00	5 00
	Library Fee	1 50	1 50
	Key Deposit........	50	50
	Total............	$52 00	$47 00
3.—Senatorial Students, (with room-mate).	Light	$2 75	$2 00
	Gymnasium Fee....	5 00	5 00
	Library Fee	1 50	1 50
	Key Deposit........	50	50
	Total............	$9 75	$9 00

The College year is divided into two semesters and all charges are required to be paid in advance, at the beginning of each semester.

The **"Incidental"** fee is applied toward the cost of Janitor service, heating, and lighting Recitation rooms, Chapel, Armory, public halls, etc. This, with the Gymnasium fee, the Library fee, and Laboratory fees, is at present the only charge made to Pennsylvania students who do not occupy College rooms.

All remittances should be made to the Treasurer, State College, Pa., by draft or money order drawn upon the State College post office.

BENEFICIARY AID, SCHOLARSHIPS, AND PRIZES

THE College has never been able to furnish a large amount of beneficiary aid to students. The amount of permanent funds for such purposes is, however, steadily increasing, and has now been placed upon a permanent basis by the generosity of two friends of the College, who have jointly made a donation of fifty thousand dollars for that purpose.

The resources now available, partly as assistance to deserving students, and partly as a recognition of honorable achievement, are as follows:

The Andrew Carnegie Beneficiary Loan Fund of $25,000, the income of which at five per centum per annum is loaned to students, without interest, under a system of regulations prescribed by the Board of Trustees, and administered by the Faculty.

The Louise Carnegie Scholarship Fund of $25,000, the income of which at five per centum per annum supports twelve annual scholarships of the value of $100 each: four for members of the Senior class; four for members of the Junior class; and four for members of the Sophomore class, under a system of regulations prescribed by the Board of Trustees, and administered by the Faculty.

The Trustees' Beneficiary Loan Fund. This fund is at present small, but is gradually increasing by the repayment of loans to students, and forms the nucleus of a permanent endowment for that purpose.

The Trustees' Freshman Scholarships, awarded to the ten students making the highest general averages in examinations for admission to the Freshman class. The Scholarships are awarded in three parts each year as a concession of room rent and incidentals, and are of the value of $85 each.

The John W. White Fellowship, Medal, and Scholarships were established in June, 1902, in honor of his father, by Mr. James G. White, of the Class of 1882.

The Fellowship is awarded to a member of the graduating class in the following manner: The names of the ten students having the highest general average in scholarship during the entire four years are submitted by the Faculty to the graduating class. From these ten the class by secret ballot selects two, and from these two the Faculty, also by secret ballot, selects the one considered most worthy of the Fellowship, which is the value of $400 and is to be held for one year. The recipient is to agree to spend the year in advanced study at this Institution or elsewhere, according to his own preference.

The Medal, of the value of $50, is awarded to the other member of the graduating class named to the Faculty by the Senior class.

The John W. White Senior Scholarship of the value of $200;

The John W. White Junior Scholarship of the value of $150, and

The John W. White Sophomore Scholarship of the value of $100 are awarded to a member of the Senior, Junior, and Sophomore classes, respectively, as follows: The Faculty by secret ballot selects one from among the ten who have attained the highest general average during the three years, two years, or one year preceding.

The Oratorical Prize of $25 is awarded to that member of the Junior class who shall excel in the composition and delivery of an English oration.

Honors at Graduation are assigned as follows:

1. Honors of the first class are awarded to the 15 per cent. or the nearest integral number thereto, of the graduates from full College courses of four years ranking highest in general scholarship; but no honor of this kind is awarded to a student having a final grade for the entire course of less than 85. Honors of the second class are awarded to an equal number of those ranking next in scholarship; but no honor of this class is awarded to a student having a final grade for the entire course of less than 80.

2. From the 50 per cent. of the graduation class having, at the close of the winter session, Senior year, the highest average grades in all subjects, the five students having the highest grades in essays and rhetoricals are assigned Commencement parts. From these five the class selects its Valedictorian, who delivers only the valedictory.

FREE (SENATORIAL) SCHOLARSHIPS

The Trustees have established fifty-four scholarships, one for each Senatorial district in the State and four to be filled by the Governor of the Commonwealth. They entitle the holder to *exemption from Room-rent and Incidentals* in any of the **Regular Four Years' College Courses.** The student, male or female, is to be appointed by the Senator of the district, or by the Governor, after a competitive examination in the studies required for admission to the Freshman class or to the second year of the Elementary Course in Mechanics. *No person is eligible as a candidate who has previously been admitted to any College class.*

The holder of the scholarship is admitted provisionally to any of the **Regular College Courses** (*but not to the Sub-Freshman class or to special courses*) free of the ordinary charge for incidentals and room-rent. This allowance amounts, at the present rate of charges, to $85 a year, and is continued during the entire College course, provided both conduct and class standing be satisfactory to the Faculty. An appointment may be made after the opening of the College year, if the appointee's attainments do not fall below the standard of the class at the time of his admission.

For information as to vacancies, time and place of examination, etc., candidates for scholarships should apply to their Senator (in whose hands the details of appointment have been placed by the College) or to the Governor or to the President of the College.

REQUIREMENTS FOR ADMISSION

1906-1907.

New Requirements for Admission will go into effect at the opening of the College year, September, 1908.

CANDIDATES for admission to the Freshman class must be at least sixteen years of age.

In all cases, they must present satisfactory testimonials of good character, and, when coming from another institution, of *honorable dismissal.*

1. For admission to the several courses, examinations are required as follows:

For the Course in General Science,
" " Agriculture,
" " Biology,
" " Chemistry,
" " Forestry,
" " Industrial Chemistry,
" " Civil Engineering,
" " Electrical Engineering,
" " Electrochemical Engineering,
" " Language and Literature,
" " Mechanical Engineering,
" " Mines and Metallurgy,
" " Mathematics,
" " Philosophy,
" " Physics,
" " Sanitary Engineering,
For the short courses in Mines and Metallurgy:

Arithmetic, including the Metric System; American History; Wentworth's *New School Algebra,* except Logarithms, or an equivalent; *Plane and Solid Geometry,* Wentworth's or Chauvenet's; the Elements of Physics, as much as is contained in either Avery (*Elements of Natural Philosophy*), Gage (*Elements of Physics*), Carhart and Chute, Hoadley, or Hall and Bergen; and, in 1907, in the following English Classics: Shakespeare's *Julius Caesar;* Burke's *Speech on Conciliation with America;* Milton's *Lycidas,* *Comus, L'Allegro,* and *Il Penseroso;* Macaulay's Essays on *Addison* and *Life of Johnson.*

2. For admission to the **Latin Scientific Course,** candidates are examined in the foregoing subjects and in Latin, as follows:

Latin Grammar (Allen and Greenough's preferred), including as much of "versification" as is necessary in order to scan dactylic hexameter verse; Cæsar's *Gallic War,* four books (or Whicher and Arrowsmith's *First Latin Readings*); six orations of Cicero, including those against Catiline and for Archias; Virgil's *Æneid,* Books I-VI; *Prose Composition,* Allen's *Introduction,* Lessons 1-52; or Jones' *Exercises,* 1-20; or Daniell's Exercises to Part III.

3. For admission to the **Classical Course,** candidates are examined in the subjects named under 1 and 2 and in Greek, as follows:

Greek Grammar (Goodwin's or Hadley's preferred), including an intelligent knowledge of Homeric verse; *Anabasis,* Books I-IV; Homer's *Iliad,* Books I-III (omitting The Catalogue of Ships); Prose Composition, Jones' *Exercises* entire, or Allison's to Part III, or Woodruff's to Book III.

4. **For the Elementary Course in Mechanics** (2 years):

The same as for the **Preparatory** or **Sub-Freshman** class. (See Index).

5. **For Special Courses.**—Applicants must be thoroughly prepared to enter the Freshman class, and, in order to take advanced work with profit, it is desirable that a student should have the foundation preparation of the full Freshman year.

6. **For Advanced Standing.**—Applicants for advanced standing in any course, in addition to satisfying the requirements for admission to the Freshman class, must pass

an examination in the studies which have been pursued by the class for which they are candidates. The Schedules of Studies indicate the amount of work now required in the various courses, but that amount may be increased at any time. Work done elsewhere is accepted when properly certified and found on examination to be equivalent in extent and quality to that required here.

Examinations for Admission to any Higher Class will be held at the College in June and September at the same time as examinations for admission to the Freshman class.

Examinations for students desiring to obtain credit for work in advance of their regular class standing will be held on the second Saturday after the opening of the fall session. Applications for such examinations, accompanied by satisfactory evidence of the completion of work for which credit is sought must be presented at the Secretary's office, on blanks to be furnished by him, not less than three days preceding the date of examination.

IN LIEU OF EXAMINATION

1. **Graduates of State Normal Schools and of a Select List of High Schools and Academies** in Pennsylvania, whose standard of requirements has been ascertained to be satisfactory, will be admitted to the Freshman class on the presentation of the proper certificate, without further examination in studies which they have successfully completed in such institution.

Certificates must show specifically the amount of work done and the text-books used in each subject. Blank forms will be furnished on application to the Registrar. Diplomas are not received without an accompanying certificate.

All admissions by certificate are regarded as merely provisional. That is, while a student presenting a proper certificate is admitted to such standing as it shows him entitled to, he may be required to take a special examination or do special work in any subject in which his preparation proves to be unsatisfactory; or if, after fair trial, he fails to maintain standing in the class to which he was admitted, he may be dropped to a lower class.

2. **The Holder of a Senatorial Scholarship** is admitted provisionally on presentation of a certificate from the Examining Committee in his district. In the absence of such certificate (or its equivalent), he is required to pass the same examination as other applicants for the Freshman class.

Examinations for Admission are held at the College on Thursday of Commencement week, and on the Tuesday preceding the opening of the fall session, the dates for 1907 being June 13 and September 17.

All examinations for admission are conducted in writing, and specimens of examination papers used in previous years will be furnished on application to the Registrar of the Faculty.

I. REQUIREMENTS FOR ADMISSION TO THE FRESHMAN CLASS

SEPTEMBER, 1908

The relative values of subjects required for admission to College are expressed in "units." A *unit* designates not less than five hours of class-room work or ten hours of laboratory work per week, continued throughout a school year of thirty-four weeks in a State Normal School, or in an accredited High School or Academy. The term *hour* indicates a class period of not less than forty minutes. *Fourteen units, as specified below, are required for admission to the Freshman class.*

ENTRANCE SUBJECTS

The following is a *complete* list of entrance subjects in which students may receive credit for admission to the Freshman class of The Pennsylvania State College. The subjects are divided into groups for convenient reference. The four subjects in the first group are required of all candidates for the Freshman class. From the remaining four groups eight units are to be taken according to the particular college course which the student intends to pursue. A statement of the specific requirements for admission to each college course follows immediately after this list of entrance subjects.

Group I

English	3	units
Algebra	1½	"
Plane Geometry	1	"
Solid Geometry	½	"

Group II

American History and Civil Government	1	unit
Ancient History to 300 A. D.	1	“
Mediaeval and Modern History	1	“
English History	1	“
General European History	1	“

Group III

Greek	2, 3, or 4	units
Latin	2, 3, or 4	“
German	2, 3, or 4	“
French	2, 3, or 4	“
Spanish	2, 3, or 4	“

Group IV

Physics	1	unit
Botany	½ or 1	“
Chemistry	½ or 1	“
Geology	½ or 1	“
Physical Geography	½ or 1	“
Zoology	½ or 1	“
Physiology	½ or 1	“
Astronomy	½	“

Group V

Trigonometry*	½ or 1	unit
Shop Work	½	“
Drawing	½	“

REQUIREMENTS FOR EACH OF THE VARIOUS COLLEGE COURSES

In connection with the following requirements, a knowledge of English Grammar and of Arithmetic, including the Metric System, is presupposed, and evidence of such preparation is required.

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*Trigonometry will be accepted on examination only.

For the Courses in General Science,
Civil Engineering,
Electrical Engineering,
Mechanical Engineering,
Mines and Metallurgy,
Industrial Chemistry,
Biology,
Physics,
Chemistry,
Mathematics,
Philosophy,
Modern Language and Literature,
Short Courses in Mines and Metallurgy.

the entrance requirements are as follows: all the subjects mentioned in Group I (six units); any two units selected from Group II; any two units from Group III; any two units from Group IV; and any two units selected from Groups II, III, IV, or V.

For the Course in Agriculture, Forestry, or Home Economics.

The entrance requirements for these three courses are the same as those given above, except that an additional unit from Group III, or an additional half-unit from Group IV or V, may be substituted for Solid Geometry (in Group I.)

For the Latin Scientific Course.

The entrance requirements are as follows: all the subjects mentioned in Group I (six units); any unit from Group II; four units of Latin from Group III; and any three additional units.

For the Classical Course.

The entrance requirements are as follows: all the subjects mentioned in Group I (six units); any unit from Group II; and seven units of Latin and Greek from Group III.

For the Elementary Course in Mechanics.

The requirements for admission to this course are the same as the entrance requirements of the Sub-Freshman class in the General Science Course.

ENTRANCE SUBJECTS IN DETAIL

Group I

ENGLISH A. For Reading and Practice. (One and a half units.) The form of examination will usually be the writing of a paragraph or two on each of several topics, to be chosen by the candidate from a considerable number,—ten or fifteen. The treatment of these topics is designed to test the candidate's power of clear expression, and will call for only a general knowledge of the subject-matter of the books. Knowledge of the text will be regarded as less important than the ability to write good English. As part of the preparation for this requirement, the student should receive instruction in the fundamental principles of rhetoric.

In place of a part or the whole of this test in English A, the student may present a certified exercise book, containing compositions written in connection with the reading of the books.

For 1908 the books assigned for "reading and practice" are as follows:

Shakespeare's *Macbeth* and *Merchant of Venice;* the *Sir Roger de Coverley Papers* in the *Spectator;* Scott's *Ivanhoe* and *The Lady of the Lake;* Irving's *Life of Goldsmith;* Coleridge's *Ancient Mariner;* Tennyson's *Gareth and Lynette, Lancelot and Elaine,* and *The Passing of Arthur;* Lowell's *The Vision of Sir Launfal;* George Eliot's *Silas Marner.*

For 1909, 1910, 1911, ten books, to be selected as follows:

I. (Two to be selected.)

Shakespeare's *As You Like It, Henry V, Julius Caesar, The Merchant of Venice, Twelfth Night.*

II. (One to be selected.)

Bacon's *Essays;* Bunyan's *The Pilgrim's Progress, Part I; The Sir Roger de Coverley Papers* in the *Spectator;* Franklin's *Autobiography.*

III. (One to be selected.)

Chaucer's *Prologue;* Spenser's *Faerie Queene,* (selections); Pope's *The Rape of the Lock;* Goldsmith's *The Deserted Village;* Palgrave's *Golden Treasury* (*First Series*) *Books II and III,* with special attention to Dryden, Collins, Gray, Cowper, and Burns.

IV. (Two to be selected.)

Goldsmith's *The Vicar of Wakefield;* Scott's *Ivanhoe;* Scott's *Quentin Durward;* Hawthorne's *The House of the Seven Gables;* Thackeray's *Henry Esmond;* Mrs. Gaskell's *Cranford;* Dickens' *A Tale of Two Cities;* George Eliot's *Silas Marner;* Blackmore's *Lorna Doone.*

V. (Two to be selected.)

Irving's *Sketch Book;* Lamb's *Essays of Elia;* De Quincey's *Joan of Arc* and *The English Mail Coach;* Carlyle's *Heroes and Hero Worship;* Emerson's *Essays* (Selected); Ruskin's *Sesame and Lilies.*

VI. (Two to be selected.)

Coleridge's *The Ancient Mariner;* Scott's *The Lady of the Lake;* Byron's *Mazeppa* and *The Prisoner of Chillon;* Palgrave's *Golden Treasury* (*First Series*) *Book IV,* with special attention to Wordsworth, Keats, and Shelley; Macaulay's *Lays of Ancient Rome;* Poe's *Poems;* Lowell's *The Vision of Sir Launfal;* Arnold's *Sohrab and Rustum;* Longfellow's *The Courtship of Miles Standish;* Tennyson's *Gareth and Lynette, Lancelot and Elaine,* and *The Passing of Arthur;* Browning's *Cavalier Tunes, The Lost Leader, How They Brought the Good News From Ghent to Aix, Evelyn Hope, Home Thoughts from Abroad, Home Thoughts from the Sea, Incident of the French Camp, The*

Boy and the Angel, One Word More, Herve Riel, Pheidippides.

ENGLISH B. For Study and Practice. (One and a half units.) This part of the examination presupposes the thorough study of each of the works named below. The examination will be upon subject-matter, form and structure. In addition, the candidate may be required to answer questions involving the essentials of English grammar, and questions on the leading facts in those periods of English literary history to which the prescribed work belongs.

The books set for this examination will be:

In 1908: Shakespeare's *Julius Caesar;* Burke's *Speech on Conciliation with America;* Macauley's *Essay on Addison* and *Life of Johnson;* and Milton's *Lycidas, Comus, L'Allegro,* and *Il Penseroso.*

In 1909, 1910, 1911: Shakespeare's *Macbeth;* Milton's *Lycidas, Comus, L'Allegro,* and *Il Penseroso;* Burke's *Speech on Conciliation with America,* or Washington's *Farewell Address* and Webster's *First Bunker Hill Oration;* Macauley's *Life of Johnson,* or Carlyle's *Essay on Burns.*

NOTE.—No candidate will be accepted in English whose work is notably defective in point of spelling, punctuation, idiom, or divsion into paragraphs.

ALGEBRA TO QUADRATICS. (One unit.) As treated in the larger academic algebras of Wells, Wentworth, Tanner, Fine, or an equivalent. The four fundamental operations; factoring; highest common factor and least common multiple; fractions (including their conception as ratios) and complex fractions; powers and roots; the solution of linear equations, both numerical and literal, and of problems depending on linear equations; radicals and the theory of exponents; and the solution of simple second degree equations in one unknown quantity by factoring.

ALGEBRA FROM QUADRATICS....(One-half unit.) As treated in the larger academic algebras of Wells, Wentworth, Tanner, Fine, or an equivalent Equations with one or more unknown quantities, to be solved by the methods of linear or quadratic equations; problems depending on quadratic equations; ratio, proportion, and variation; variables and limits; properties of series, including the binomial theorem for positive integral exponents, and the formulas for the *n*th term and sum of the terms of arithmetical and geometrical progressions, with applications; logarithms.

PLANE GEOMETRY. (One unit.) As treated by Wentworth, McMahon, Phillips and Fisher, or an equivalent. The usual theorms and constructions, including the general properties of plane rectilinear figures, the circle, and measurement of angles, similar polygons, areas, regular polygons, and the measurement of the circle; the solution of original exercises, including loci problems; and the application to the mensuration of lines and plane surfaces. The student should be able to prove every statement made, going back step by step until it rests upon primary definitions or axioms.

SOLID GEOMETRY. (One-half unit.) As treated by Wentworth, McMahon, Phillips, and Fisher, or an equivalent. The usual theorems and constructions, including the relations of planes and lines in space, the properties and measurement of prisms, pyramids, cylinders, and cones; the sphere and spherical triangle; the solution of numerous original exercises, including loci problems; applications to the mensuration of surfaces and solids; and an ability to apply Solid Geometry to practical problems.

Group II

AMERICAN HISTORY AND CIVIL GOVERNMENT. (One unit.) (a) Channing's *Students' History of the United States,* McLaughlin's *History of the American Nation,* Hart's *Essentials in American History,* or an equivalent. The discovery, exploration, and settlement of

America; the colonial policy of England, culminating in the Revolution; the political, economic, and social history of the United States since the adoption of the Constitution. (b) Fiske's *Civil Government,* or Boynton's *School Civics,* or an equivalent. A knowledge of the chief organs of local, state, and national governments, their relation to each other, and the functions assigned to each; and a special knowledge of the government of the state from which the student comes.

For satisfactory entrance credit, this course in American History and Civil Government should not be given before the student enters the high school, and preferably not before the third year in the high school.

ANCIENT HISTORY TO 300 A. D. (One unit.) If a single text-book is used, it should be West's *Ancient World,* Wolfson's *Essentials in Ancient History,* Morey's *Outlines of Ancient History,* or an equivalent; if separate texts are preferred, Botsford's *Rome* and *Greece,* Myers' *Eastern Nations and Greece,* and *Rome, its Rise and Fall,* are recommended. (1) Greek history to the fall of Corinth, with some attention to the history of some of the more ancient countries, and with due emphasis upon the social, literary and artistic side of Greek life; (2) the history of the Roman Republic and of the Empire to the time of Constantine, with special stress upon the period of the Empire.

MEDIAEVAL AND MODERN EUROPEAN HISTORY. (One unit.) Harding's *Essentials in Mediaeval and Modern History,* West's *Modern History,* Munro and Whitcomb's *Mediaeval and Modern History,* or an equivalent.

ENGLISH HISTORY. (One unit.) Cheyney's *A Short History of England,* Andrews' *History of England,* Walker's *Essentials in English History,* Terry's *History of England for Schools,* or an equivalent.

GENERAL EUROPEAN HISTORY. (One unit.) Adams' *European History,* or an equivalent.

In all the foregoing courses, the student should also have adequate preparation in historical geography, considerable collateral reading, and practice in note-taking.

The entrance examinations in History will be so framed as to require comparison and the use of the judgment, rather than the mere use of the memory.

NOTE.—The American Historical Association, through the Report of its Committee of Seven, and the leading universities and colleges, have recommended the following courses of study in History for all secondary schools:

First year, Ancient History to 800 A. D.
Second year, Mediæval and Modern European History.
Third year, English History.
Fourth year, American History and Civil Government.

This plan is very strongly recommended to the schools sending students to The Pennsylvania State College.

Group III

GREEK. (First unit.) White's *First Lessons in Greek* or *First Greek Book,* or an equivalent. The reading and translation of the first book of Xenophon's *Anabasis.* Special attention should be given to pronunciation, accent, inflection, and the general essentials of grammar.

GREEK. (Second unit.) Goodwin's, or Hadley and Allen's *Greek Grammar;* any standard edition of Xenophon's *Anabasis;* Jones' *Greek Composition,* or Sidgwick's *Greek Writer.* Systematic and thorough study of Greek grammar; special drill in syntax; the translation of books II, III, and IV of the *Anabasis;* thorough drill in Greek Composition; history of the period in which Xenophon lived.

GREEK. (Third unit.) First three books of Homer's *Iliad* (any standard text); versification, and the oral and written scanning of Homer's *Iliad;* Greek Composition continued and completed; a review of the first four books of the *Anabasis.*

GREEK. (Fourth unit.) An additional unit of Greek may be offered; the subject and the amount of work required for this fourth unit can be determined by correspondence with the Registrar.

LATIN. (First unit.) Collar and Daniell's *Beginner's Latin Book* and some standard *Latin Grmamar,* such as Allen and Greenough's or Bennett's. Drill in pronunciation by the Roman method, inflection, and the important parts of syntax; the reading and translation of simple selections from Caesar's *Gallic War.*

LATIN. (Second unit.) Allen and Greenough's, or Bennett's *Latin Grammar,* or an equivalent; first four books of Caesar's *Gallic War* (any standard text): and Allen's *Introduction to Latin Writing,* or an equivalent. The grammar should be studied fully and systematically; the Latin text should be translated into idiomatic English; and the student should be drilled twice a week in Latin Composition.

LATIN. (Third unit.) The first six books of Virgil's *Æneid* (any standard text). Quantity and versification, and the oral and written scanning of dactylic hexameter: the student should be able to scan every verse of Virgil; study of etymology and syntax, as called for in the reading; Latin Composition continued twice a week; history of the times of Caesar, Cicero, and Virgil.

LATIN. (Fourth unit.) Six *Orations* of Cicero: the four orations against Catiline, the oration of Archias, and any other oration (any standard text); the reading of Latin at sight; review of Caesar and Virgil. In the study of Cicero special attention should be given to syntax, to the grammar of moods and tenses, and to the derivation of words. Latin Composition may be continued so as to include fifty-two lessons in Allen's text-book.

NOTE.—virgil may be taken after Cicero; and an equal amount of Ovid may be substituted for Virgil, or of Sallust and Nepos for Cæsar.

ELEMENTARY GERMAN. (Two units.) Joynes-Meissner's *German Grammar.* Any standard German reader, or graduated texts. Two years in the preparatory school should be given to elementary German. The rudiments of grammar should be mastered; that is, the inflections and the rules of syntax and of word-order, as much as is contained in Lessons I-XLV of Joynes-Meissner's *Grammar.* The Reading and translation of about 450 pages of German texts. Constant practice in translating from English into German.

INTERMEDIATE GERMAN. (One unit.) In addition to the foregoing, the reading of about 400 pages of moderately difficult German prose and poetry. Grammar reviewed and completed, with special attention to the more difficult and less usual parts of inflection, syntax, word-order, and word-formation.

ADVANCED GERMAN. (One unit.) The reading of about 500 pages of good literature in prose and poetry; collateral reading about the lives and works of the writers studied; the translation of English into German, and the writing in German of numerous short themes.

ELEMENTARY FRENCH. (Two units.) Aldrich and Foster's *Foundations of French* and *French Reader,* or their equivalents. Two years should be devoted to this preparatory work. The rudiments of grammar should be mastered, and about 450 pages of graduated texts should be read. Constant practice in translating from English into French.

INTERMEDIATE FRENCH. (One unit.) In addition to the foregoing, the reading and rendering into idiomatic English of not less than 400 pages of moderately difficult French prose and drama; grammar reviewed and completed, with special attention to idioms and syntax; frequent exercises in composition and dictation.

ADVANCED FRENCH. (One unit.) The reading of 600 pages of at least five different representative authors belonging to the classic and modern periods; an introduction to French literature, emphasizing prominent writers, periods, and movements; practice in dictation and theme-writing in French.

ELEMENTARY SPANISH. (Two units.) Geise's *Spanish Book and Reader,* or an equivalent; standard texts. Two years of preparatory work, including the rudiments of grammar and the reading of not less than 350 pages of Spanish, and practice in translating from English into Spanish.

INTERMEDIATE SPANISH. (One unit.) The reading of 400 pages of moderately difficult Spanish, from the works of at least three different authors; grammar reviewed and completed; exercises in composition and dictation.

ADVANCED SPANISH. (One unit.) The reading of 500 pages from authors representing different periods (a part to be taken from dramatic literature); an introduction to Spanish literature; abundant practice in theme-writing and dictation.

Group IV

PHYSICS. (One unit.) As much as is contained in the text-books of Carhart and Chute, Hoadly, Hall and Bergen, Gage's *Elements of Physics,* Avery's *Elements of Natural Philosophy,* or an equivalent.

BOTANY. (One unit.) As much as is contained in Gray's *Lessons,* Bailey's *Elementary Botany,* Bergen's *Foundations,* or an equivalent. The entire book should be studied.

BOTANY. (One-half unit.) As much as is contained in the first 155 pages of Gray's *Lessons;* or the first

178 pages of Bailey's *Elementary Botany;* or the first 227 pages of Bergen's *Foundations;* or an equivalent.

CHEMISTRY. (One unit.) The study of at least one standard text-book. A comprehensive and connected knowledge of the most important facts and laws of elementary chemistry. Laboratory work is essential, and original notes must be submitted. More attention should be given to descriptive chemistry than to analytical, and the student should become as familiar as possible with the commonest non-metal and metals, and their simpler compounds. Thorough knowledge of the meaning of the chemical equations, facility in the use of the Metric System, and familiarity with the correct solution of problems based on weight and volume relations of equations, are indispensable.

CHEMISTRY. (One-half unit.) One-half of the work described above. More definite information may be obtained by writing to the Registrar.

GEOLOGY. (One unit.) LeConte's *Elements of Geology,* Scott's *Introduction to Geology,* or an equivalent. The preparation in Dynamical and Structural Geology should be very thorough. In Stratigraphical or Historical Geology the student should memorize the names of the geologicol formations, and become familiar with the typical life and climate of these formations. The student should also make accurate field observations of the geological phenomena in the vicinity of his home.

GEOLOGY. (One-half unit.) The subjects mentioned above, as treated in the elementary text-books of Dana, Brigham, Norton, Tarr, Le Conte's *Compend,* or an equivalent.

PHYSICAL GEOGRAPHY OR PHYSIOGRAPHY. (One unit.) Salisbury's *Physiography* or

Chamberlin and Salisbury's *Geology* (Vol. I.), or an equivalent. The general phenomena of the earth, including its atmosphere, surface and underground waters, the configuration of the land, the manifestations of its interior heat, and the distribution of plant and animal life. Field observations should be made of the physiographic processes in the vicinity of the student's home. Use can be made of Darling's Manual.

PHYSICAL GEOGRAPHY OR PHYSIOGRAPHY. (One-half unit.) The text-books on Physical Geography by Gilbert and Brigham, Davis, Dryer, Fairbanks, Mill, Redway, Tarr, Thornton, or an equivalent.

ZOOLOGY. (One unit.) Carlton's *Practical Zoology,* Jordan and Kellog's *Animal Life,* Kellog's *Elementary Zoology,* or an equivalent. As much time should be given to laboratory and field work as is given to the study of the text-book. A special study should be made of the external and internal anatomy of six or seven different animal types; the general physiology of these types; the principal facts of reproduction, and the embryological development of a fish or a frog; the general facts of evolution; and the idea of classification, development by practical work with representative animals. Certified note-books and drawings, showing the character of the work done, must be submitted. The drawings should be made from the animals themselves, and the notes must be a record of the student's own observations.

ZOOLOGY. (One-half unit.) The study of the text-book as given above, without the laboratory and field work.

PHYSIOLOGY. (One unit.) Martin's *Briefer Course,* or an equivalent. Special attention to the anatomy, histology, and physiology of the human body, and the essentials of hygiene. In addition to the study of the text-book, the course must include considerable practical laboratory work, consisting of experiments and dissections of the organs of some mammal. Histology should be studied by means of miscroscopic sections. Certified drawings and notes must be submitted.

PHYSIOLOGY. (One-half unit.) The study of the text-book as given above, without the laboratory work.

ASTRONOMY. (One-half unit.) As much as is contained in Sharpless and Phillips' *Astronomy,* or an equivalent.

Group V

PLANE TRIGONOMETRY. (One unit.) As treated by Chauvenet, Wells, Murray, or any other standard authority. The definitions and relations of the trigonometric functions as ratios; circular measurement of angles; proofs of the principal formulas, and particularly the special formulas for the solution of triangles; the transformation of trigonometric expressions by means of these formulas; the solution of trigonometric equations of a simple character; the theory and use of logarithms; the solution of right and oblique triangles, and applications.

PLANE TRIGONOMETRY. (One-half unit.) One half the work described above. More definite information may be obtained by writing to the Registrar.

SHOP WORK. (One-half unit.) A student who offers Shop Work as an entrance subject is asked to present a detailed statement from his instructor, setting forth the kind and amount of work done. The kind of Shop Work that will be acceptable can be determined by correspondence with the Registrar.

DRAWING. (One-half unit.) Certified specimens of the student's work should be submitted. A statement from the instructor as to the quantity and quality of work done is also desirable. The amount and kind of work expected can best be determined by writing to the Registrar.

CERTIFICATES ACCEPTED IN LIEU OF EXAMINATIONS

Graduates of State Normal Schools and of a Select List of High Schools and Academies in Pennsylvania, whose standard of requirements has been ascertained to be satisfactory, will be admitted to Freshman class on the presentation of the proper certificate, without further examination in studies which they have successfully completed in such institution.

Certificates must show specifically the amount of work done and the text-books used in each subject. Blank forms will be furnished on application to the Registrar. Diplomas are not received without an accompanying certificate.

All admissions by certificate are regarded as merely provisional. That is, while a student presenting a proper certificate is admitted to such standing as it shows him entitled to, he may be required to take a special examination or to do special work in any subject in which his preparation proves to be unsatisfactory; or if, after fair trial, he fails to maintain standing in the class to which he was admitted, he may be dropped to a lower class.

The holder of a Senatorial Scholarship is admitted provisionally on presentation of a certificate from the Examining Committee in his district. In the absence of such certificate (or its equivalent), he is required to pass the same examination as other applicants for the Freshman class.

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MEANS OF ACCESS

The College is easily accessible from every part of the State.

1. A railroad from Montandon, on the Philadelphia and Erie Road to Bellefonte, passes within about two and one-half miles of the College, at Lemont. The public conveyance for the College meets every train at Lemont. At the beginning and close of each term free conveyance for specified trains is provided between Lemont and the College for all students.

2. Passengers from the northern, northeastern and eastern parts of the State can most conveniently reach Lemont by way of Montandon. Those from the northwestern parts can come directly to State College by way of Lock Haven and Bellefonte; and those from the western and southern parts, by way of Tyrone, on the Pennsylvania Railroad (Main Line) and Bellefonte. The last named route can also be taken by those coming from the east.

3. A railroad from Bellefonte runs directly to the College grounds in the borough of State College.

The postoffice, railroad, telegraph and express direction is "State College, Pa."

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